SCIENTIFIC AMERICAN

No. SUPPLEMENT 507

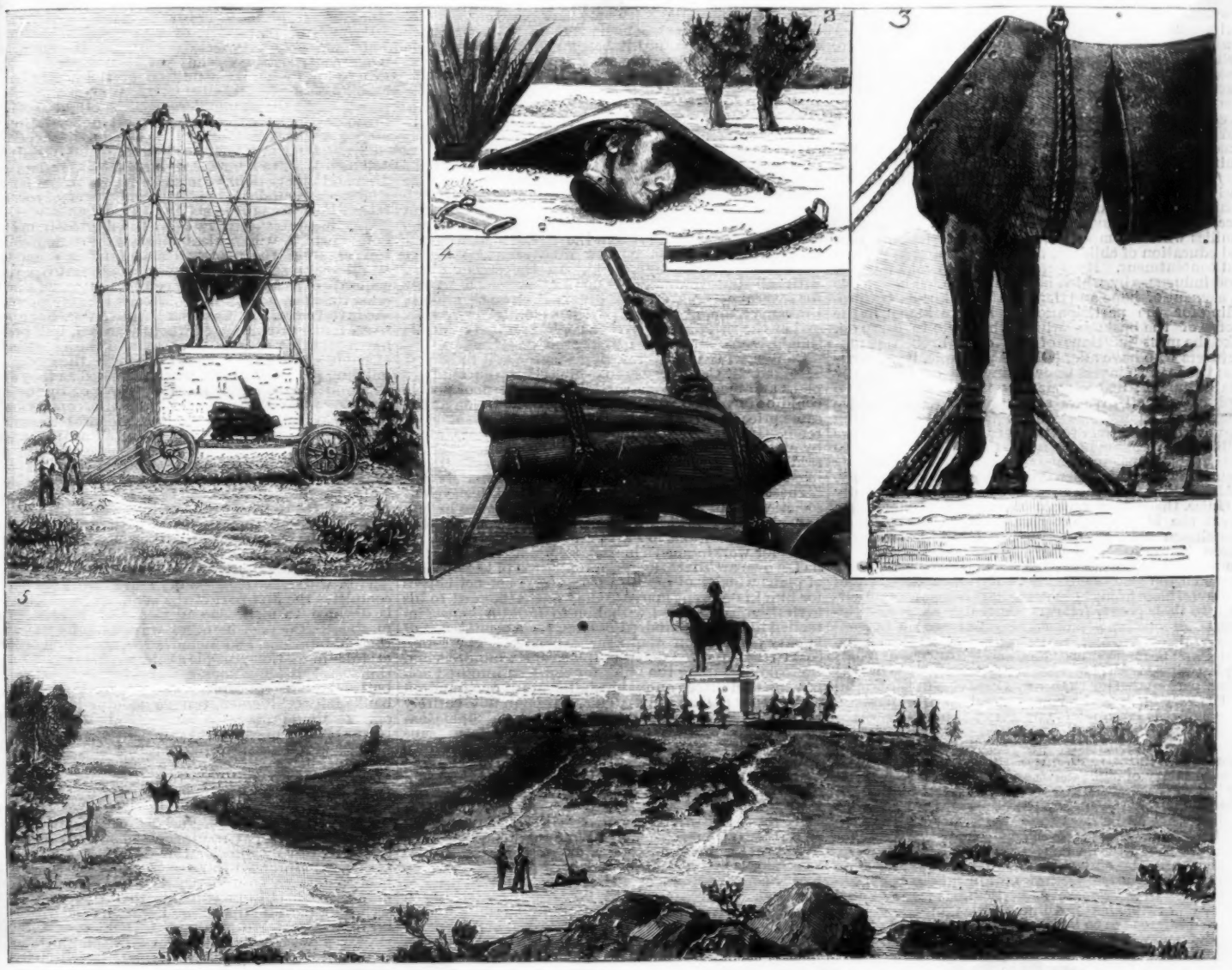
Scientific American Supplement, Vol. XX., No. 507. NEW YORK, SEPTEMBER 19, 1885. Scientific American Supplement, $5 a year.
Scientific American, established 1845. Scientific American and Supplement, $7 a year.

FROM LA NATURE.

WE give this week several interesting illustrated articles from our excellent contemporary *La Nature*, among which are the following: Photography in a Balloon, A Useful Acaridan, The Cylindrograph, Physiological Curiosities, The Lapps, Biological Study of Water, High Speed Motor.

THE WELLINGTON STATUE AT ALDERSHOT.

THE monument of the great Duke of Wellington, which has recently been erected at Aldershot, stands on a small hill called the "Round Hill," in close proximity to the Queen's Pavilion (South Camp), in an angle formed by the Farnborough Road and that leading to the Long Valley. It faces southwest, the horse's head being inclined toward the Pavilion, while the Duke is pointing in the direction of the Long Valley, the scene of many fights of modern times. The pedestal is perhaps a little small, and the statue does not, being situated in so open a place, appear quite so large or imposing as it did at Hyde Park Corner. But the position is, on the whole, well chosen, and it can be seen from many parts of the camp. The appearance presented by the statue during the process of erection was sufficiently ludicrous to afford subjects for the accompanying sketches. Near the scaffolding the body of the Great Duke in his martial cloak lay on an open truck bound by ropes, the hand pointing in an aimless manner to the skies, the head in its cocked hat lay some yards distant gazing into the ground, the plumes stood erect like a sheaf of corn, while a few feet to the left lay sword, belt, and scabbard. It is gratifying, however, to relate that His Grace did not long remain in this undignified position, for in the hands of the contractor all the parts have been rapidly adjusted in their respective places, and the monument now presents a finished appearance, and will no doubt be fully appreciated in the military camp where it has been so suitably placed.—Our engravings are from sketches by Captain the Hon. Alwyne Greville.—*London Graphic.*



1. From the Farnborough Road. 2. The Cocked Hat and Feathers. 3. A Closer Inspection of His Grace's Horse. 3. His Grace's Body Tied and Bound. 5. The Statue Completed—General View.

THE ERECTION OF THE DUKE OF WELLINGTON'S STATUE AT ALDERSHOT.

HOW TO CARE FOR OUR POOR FELLOW CITIZENS.*

FOR those persons who like to trace the development of the moral impulses which belong to successive periods of history, there could hardly be a pleasanter study than that of the growth, during the last two or three decades, of the sentiment of sympathy for the trials and privations of the very poor, which shows itself in earnest and thoughtful efforts to ameliorate them in the most judicious way. Although an infinite amount of work for this end remains to be done, a great step has been gained in diffusing a knowledge of the spirit in which that work should be carried on, to avoid injury to those for whose benefit it is intended; and all those intelligent persons who sincerely wish to make the lives of a few of their fellow men happier than they would have been without their aid, have now a general idea of the mode in which their benevolent impulses should be carried into effect. Unfortunately, in most cases it is only a general idea, the particulars derived from the study of the results of previous experiments of the kind being rarely known outside of the limited circle of persons immediately concerned; and for want of these particulars a great deal of charitable work is done to little or no purpose, which might have been far better directed if the means had been at hand for studying the experience of others in similar work. Nearly every one who has interested himself in any philanthropic movement has felt the need of such information, and several efforts have been recently made to supply it by means of a class of books among which the one before us stands pre-eminent, both for the extent of the ground which it covers and the thoroughness with which examples of as many different kinds as possible are collated and described.

The author of the work is a professional man of considerable distinction, who, as we learn incidentally from the text, came into possession of a property, much of which was invested in tenements for poor people. With characteristic energy and good feeling, he undertook to make himself acquainted with his tenants and their homes, and, so far as possible, to use his superior knowledge in promoting their health and comfort; and later, through his study of their lives, he was led to consider seriously the whole problem of the amelioration of the condition of the class to which they belonged. As a preliminary to an attempt at the partial resolution of this problem, he gathered together all the information within his reach in regard to what had been done in France and other countries in the way of constructing improved dwellings for working people, of forming building and other co-operative associations among them, of establishing clubs for amusement and instruction, and of building and managing hospitals, schools, and asylums of all kinds.

This theoretical study was followed by practical essays at constructing improved dwellings and at forming co-operative associations, and the history of these attempts is combined with a clear and concise presentation of the information on the subject collected

* L'Economiste Pratique. Construction et Organization des Creches, Salles d'Asile, Ecoles, Habitations Ouvrieres et Maisons d'Employes, Hotels pour Celibataires, Cuisines Economiques, Bains, Lavoirs, Cercles Populaires, Nourriceries, Maternites, Dispensaires, Hopitaux, Hospices, Asiles de Nuit, Postes de Secours. Par Emile Cacheux. Paris: Baudry et Cie., 15 Rue des Saints Peres, 1885. Price, 40 francs.

from the most diverse sources, to form a book of the greatest interest and value, not only to the students and practitioners of benevolence on a large scale, but to architects and sanitarians, who are often called upon to provide designs for such establishments as those of which M. Cacheux treats, but find it difficult to collect examples upon which their studies may be based.

The writer begins his work with an introduction so forcible and intelligent that we are tempted to translate it in full, but it would be fairer to him to leave that pleasure to his own readers, and we will content ourselves with quoting his encouraging expression of his belief, that although the number of the wretchedly poor does not sensibly diminish in most civilized countries, and although ninety thousand people die every year in France of want, nevertheless the enlightened efforts of the past twenty years have begun to show some fruit, and while in England, or at least in London, the number of registered paupers is now materially lessening, in France, mainly through the influence of M. Godin and various other chiefs of great industrial establishments, the lot of poor working people has been ameliorated in a different way, and those who are willing to live industriously and virtuously may now in that country in many cases look forward to a future of comfort and security such as they could not have hoped for a few years ago.

Of course the whole science of modern philanthropy is now in the experimental stage, and it is fortunate that circumstances or individual inclination has led to great variety in the experiments which have been tried, so that, although no one of them has completely solved the problem to which it was applied, each has been the means of establishing principles and furnishing precedents to guide future efforts. The two extremes of philanthropic sentiment, as exhibited in practical effort, are perhaps best represented in the experiments at Guise and at Mulhouse. In the former town, M. Godin, a maker of stove castings, of a mildly socialistic turn of mind, but much real ability, undertook to gather his workmen around him in a vast co-operative housekeeping establishment, which he called a *familistere*, probably in imitation of Fourier's celebrated communistic *Phalanstere*. Living among his men, and exercising on them and their families, by his own force of mind rather than his position, an almost unlimited influence, M. Godin was soon led, as the size of his *familistere* increased with the extension of his business, to establish a set of rules for the government of his great household, which have proved extremely successful in securing industry and morality among the families which compose it, in providing for the care and education of children, and in promoting happiness and contentment. More recently he has added to the good influences by which he has surrounded his people an element of hope and legitimate ambition, by providing for the participation of his workmen in the profits of the business which they help to carry on. Like the most judicious of the other French manufacturers who have adopted this principle, he encourages the men to invest their savings as capital in the establishment; and so generally is this done, and so rapidly do small savings aggregate into considerable sums, that the business will, it is said, before many years virtually belong to the persons who, if they are willing to exercise a little more forethought and discretion than most workmen show, are best fitted by their knowledge of its details to carry it on successfully.

Although M. Godin's scheme has worked successfully at Guise, there is a certain flavor of sentimentalism about the idea which perhaps adapts it better to Frenchmen than to workingmen of Saxon descent, whose tastes seem to have been better suited by the more prosaic though equally admirable provisions by which the manufacturers of the Alsatian town of Mulhouse have brought so much happiness and contentment to their poorer fellows. At Guise all is vast; interests, amusements, and occupations are all in common, and on a great scale; while at Mulhouse the individual becomes prominent, and the science of securing happiness with sixpences is the one which is taught there, perhaps better than anywhere else in the world. At the very birth of the young Alsatian workingman, his comfort is provided for by a sort of baby-insurance system, under which all the young married women employed in the mills are encouraged to pay a small regular sum into a fund, out of which, when a baby is born, a salary of eight dollars a month, as a substitute for the wages she would lose, is paid to the mother for three months, on condition that she stays at home during that time and nurses and cares for her child. When the baby is old enough, excellent schools are ready for him; and even after he has begun work in the factory, evening schools and industrial museums give him technical instruction, from the rudiments to the highest grade. In later years, domestic life is made as easy and comfortable as possible. Pleasant and well-planned houses are to be hired at a reasonable rent, and the tenant who pays his rent regularly for fourteen years then becomes the absolute proprietor of his house. This provision tends strongly to fix families in their homes, and makes it possible to establish in various localities those co-operative stores, bakeries, and restaurants which prosper so well in communities where all the members are known to each other, and usually fail so miserably where they have to depend upon a shifting population. To encourage hope and zeal in the operatives, the system of participation in profits is carried out very generally, in ways differing according to circumstances or the fancy of those who have established it in each case; and insurance of all sorts, against accidents, fire, strikes, sickness, old age, infirmity, and death, can be had at low rates, while well-organized charitable societies, dividing the city into districts, after the fashion of our best associations of the kind, find out and help those whom unavoidable calamity has made dependent upon the good offices of their fellow men. So thoroughly is this work done, and so generally is the habit of modest thrift diffused in the community, that even the terrible war of 1870, which raged about the city, and ended in the conquest of the province in which it is situated, caused no permanent injury to the manufacturing interests of the place, and not even temporary suffering from actual want to any of the forty thousand operatives employed there. It is impossible to read of this without lamenting, as M. Cacheux does, that the principles of practical benevolence followed at Mulhouse should not be adopted in larger cities. In Paris particularly, as he says, although those who have money are generous in giving it for what they call charity, they trouble themselves very little about the way in which it is distributed; and the result is, as has been established by investigations made with the lists of persons receiving aid from benevolent societies in the hand of the inspector, that ninety-eight per cent. of names on the lists are those of able-bodied drones, thieves, and swindlers, and that only two out of every hundred, on an average, are those of persons who really need assistance. Of course there are always, in every large city, sick and helpless people enough to employ with advantage all the resources that the most profuse benevolence can furnish, but these people are almost always too young, too modest, or too proud to apply for help; and as the benevolent societies are not energetic enough to hunt them out, the charity intended for them is appropriated by the gamblers and tramps who besiege such societies with their impudent fictions.

We have delayed a little over these introductory remarks of our author, partly to show how thoroughly he understands what is the object to be aimed at in spending money for the good of the poor, and partly for the sake of suggesting concisely the lesson which the author constantly teaches in his book, in ways which we shall not here be able to follow; and can only briefly notice the most interesting of the practical chapters, in which the author narrates his own experiences in building workingmen's houses in Paris.

His visits to the five hundred families occupying the buildings which he had acquired, just before his studies in social science began, having shown him the unwholesomeness of the conditions under which they lived, he began his efforts to ameliorate these conditions by visiting, as he says, several thousand workingmen's dwellings in Paris, and found that in nearly all, as in his own, their occupants were lodged in a manner "quite incompatible with the laws of morality or hygiene." Not one tenement out of ten comprised three rooms besides the kitchen, and thousands of them consisted of one room for all purposes; while, as the statistician of the Government informed him, half the workingmen's families in Paris included more than four persons. The consequence of crowding families into such insufficient space he found to be serious. In the first place, the father of the family, annoyed by the confusion about him at home, was driven to spend his evenings outside, usually at the wine-shop, where he squandered both his earnings and his health, while the women and children, who remained in the house, suffered not only from the closeness and confusion, but still more from the smells of the cooking, washing, and drying of dirty clothes before the fire, which, as some of them must, in such narrow quarters, sleep in the kitchen, they could not avoid. In the second place, with all but the smallest families, it was necessary for several persons, often of different sexes, to sleep in the same room, at the risk of their morals in any case, and at the risk of their lives, also, if a serious epidemic should break out in the neighborhood.

Convinced that overcrowding was the evil to be first attacked, M. Cacheux betook himself to the study of plans and modes of construction by which poor people could be furnished with proper accommodation at the same price that they had been paying for insufficient room. In this investigation he spent three years, aided by experts of high reputation, and after publishing the results of his study in a book on Workingmen's Dwellings in All Countries, which gained immediately the highest commendation from officials and benevolent societies, he proceeded to apply the knowledge he had gained to his Parisian problem. There have been several competitions in Paris, on various occasions, for plans for workingmen's houses, and, not venturing to be his own architect, he requested three of the authors of plans which had received prizes to construct houses for him in different places. Only one responded to his invitation, and agreed with him to build a house, intended to cost six hundred dollars, for a commission of twenty per cent. on the sum expended. The house cost twelve hundred dollars in place of six hundred, and was sold, including the land, for eighteen hundred dollars, paid in fifteen annual installments of one hundred and twenty dollars each. This, although not entirely unprofitable, was a less successful financial operation than the construction of some other houses, from plans given in the book, which cost eight hundred and eighty dollars each, without the land, or twelve hundred including land, fences and wells complete, and sold readily for eighteen hundred dollars, payable in fifteen installments, as in the first case.

By these and other experiments the author was led to the conclusion that twelve hundred dollars was the least sum for which a detached house, containing three rooms besides the kitchen and outbuildings, could be had within the limits of Paris, including the price of the land. Something might, however, be saved both in land and in cost of construction by building houses contiguous, with party walls between, and another essay was made by contracting for a block of ten houses, each of one story, comprising three rooms and kitchen, with a cellar, at seventy-two hundred dollars for the entire block. These houses, which were certainly cheap enough, were afterward transferred at the cost price to a philanthropic building society, which sold them, including the land, the value of which would naturally have been considerably less than in the previous instances, at seventeen hundred and fifty-two dollars each, payable in twenty annual installments. Other ventures of different kinds followed these, with the same general result, so that, as M. Cacheux says, out of about twenty different types of houses containing from three to ten rooms, and costing from six hundred to three thousand dollars each, but all intended to be occupied by one family, there was not one that could not be sold on annual installments at a price which would return five per cent. interest on the investment, while the amount of each annual installment was little greater than the bare rent which would have to be paid for the same accommodation in a tenement-house.

Unfortunately it is not always easy to find cheap land within the boundaries of a great city, and those who wish to improve the condition of their poorer fellows are always brought, sooner or later, to the problem of housing them decently in large buildings, a problem which is rendered more difficult by the fact that clean and wholesome tenement-houses have to compete in rent with vile old rookeries, for which any price is a profit; and it is found in practice that more than three per cent. interest can rarely be obtained from such property, carried on by the owner in any decent manner. One who is satisfied with this can, however, generally be sure of keeping his houses full of respectable and honest tenants, and is in a position, by making their tenure depend upon their conduct, to exercise a most salutary influence over them. Curiously enough, the worst enemy to be encountered in carrying on such efforts to do good appears to be public charity of the ordinary kind. M. Cacheux illustrates this in part by citing the case of two of his own tenants. One of these hired expensive rooms in the front of the building, with a view down the street. The family went often to the theater, and the head of it always stayed away from his work on Mondays, to recover from the effects of his Sunday recreation. The rooms were always dirty and ill-kept, and the children neglected. A part of this tenant's rent was paid for him by a charitable society. The other tenant hired cheap rooms in the rear of the building, looking out on a court, but paid the rent himself. He and his wife worked hard, but they found time to keep their rooms clean and to bring up their children with tender and judicious care; while their neighbors in the front rooms were being encouraged in idleness and vice by the most effective means, under the name of charity. It is not wonderful that the poor, with such examples before them, have but a mean opinion of the justice of society, and learn to hate and despise that charity which seems to them to choose for its objects the persons who deserve it least. This feeling perhaps does something to strengthen the sentiment of independence, which is so strong, even among the poorest, that, as M. Cacheux says, it is difficult to find good tenants in Paris for the improved houses built professedly for a charitable purpose; the decent and self-respecting families preferring to pay the same rent in a common tenement-house, rather than put themselves, even in imagination, under obligation to philanthropists.

Beyond the promotion of a personal acquaintance and mutual good feeling between landlords and tenants, little progress has yet been made anywhere toward improving the condition of the very poor inhabitants of city tenements. A proper surveillance may prevent them from fleecing each other, as some of them, particularly the Irish, do most unmercifully; one house, of which M. Cacheux speaks, having been rented by the owner for one hundred and twenty-five dollars a year, to a tenant who sublet it for two hundred and ninety dollars, in small tenements, to families who again rented single rooms and parts of rooms at rates which brought in six hundred dollars a year; but no one has yet shown how to build great tenement-houses which will, unless under exceptional circumstances, afford the poorest class of laborers and their families, at a rent which they can afford to pay, the comforts of a clean and respectable home, and at the same time pay a continuous interest of six per cent. on the investment. M. Cacheux himself does not appear to see much promise in efforts to this end, but prefers, like most other experts, to encourage the construction of small, single houses, either through the medium of building societies, which, when managed as they are in England, he commends most warmly, or by the safer method of leaving the care of the first operations of purchasing land and constructing houses to prudent business men, who make sales on installments at reasonable rates of interest, and thus, without losing anything themselves, teach and encourage their customers to take their affairs gradually into their own hands. This plan has actually been carried out with success by M. Cacheux and some of his friends, and the complete presentation of their scheme, with drawings of the houses built, and copies of their by-laws, leases, regulations for tenants, and contracts, which are given in the book, is full of interest and instruction.

This, with some explanatory and illustrative matter, completes the first part of the book. The second part is devoted to methods and means of lightening the burdens of the poor in other ways than by improving their habitations, and includes the most practical and useful information possible about workingmen's restaurants and lodging-houses, nurseries, schools, public baths, laundries, hospitals of various kinds, clubs and banks for workingmen, tramps' lodging-houses, and so on. It would take too long even to indicate in the briefest manner the variety of documents, specifications, models of reports, regulations, statutes, and statistics which are here collected, after a choice made with admirable judgment. It is true that they serve to give the pages of the book a dry, matter-of-fact look, which will probably repel the sentimental amateur of benevolence, who likes to feel himself gushing with sympathy over tales of woe, without the inconvenience of bringing his emotions to any practical result; but for people of action, who propose to do something for their fellow men, and wish to set about it to the best advantage, nothing could be more valuable than these detailed descriptions of the actual administration of charities similar to those which they desire to help in establishing. On the subject of day-nurseries alone, for instance, we find a hundred pages of information collected from France, England, Germany, and Holland; while a still larger space is devoted to co-operative societies, savings-banks, and insurance associations, including an abstract of the attempts which have been made in France to enable workmen to participate in the profits of the business which they help to carry on. It will be seen that although we have quoted pretty liberally—although not so liberally as we should have liked—from certain portions of this admirable book, there is plenty of matter left, to which we have not been able to refer; and we quiet without difficulty the conscience which always reproaches us when we use the work of other people to give interest to our own, by the reflection that a more meager account of the book would have given a very inadequate idea of what is a veritable encyclopædia for the benevolent.—*Amer. Architect.*

As a final result of his experiences, Prof. Schede asserts that whoever makes use of corrosive sublimate as a surgical dressing, with the necessary precautions, will find it not only the most reliable and efficient disinfectant, but one that will promote the rapid healing of wounds more than any other, and is at the same time more free from disagreeable or dangerous secondary effects than any other.

According to the *Annals of Surgery*, these are the results of nearly 1,300 operations performed at the Hamburg Clinic for the thirty months during which corrosive sublimate was used, and ending the 1st of August, 1884.

COTTAGES, ASKHAM, YORK.

THESE houses have been built by Sir Andrew Fairbairn, M.P., whose country seat is at Askham.

The aim of the architects, Messrs. Chorley and Connon, Leeds, has been to design cottages that would picturesquely blend with the woodland scenery amid which they are placed; and in this they have been materially assisted by Sir Andrew Fairbairn, who has looked rather to the comfort of his tenants than to considerations of economy.

The buildings are of red brick, tile roofed, and the woodwork finished in harmonious colors.—*Building and Engineering Times.*

THE NEW FEDERAL BUILDING, BROOKLYN, NEW YORK.

THIS structure, as our readers can judge from the illustration, will be "a thing of beauty," something indeed worthy of Brooklyn.

While Mr. M. E. Bell, the architect of the Treasury Department, provides an exterior that will appear as a monument of his skill, the internal conveniences will doubtless prove to be all that judgment and good taste could suggest.

Over sixteen years ago it was generally conceded that such a building was an absolute necessity, and the matter was vigorously agitated, but it was not until the Congress of 1883 that the united efforts of the Hon. J. Hyatt Smith, Hon. A. M. Bliss, and the Hon. Wm. E. Robinson secured the first appropriation of $300,000, an amount quite inadequate, of course, but something substantial at least to start with. This amount was subsequently increased to $500,000.

After many delays and disappointments with regard to a suitable site, Secretary Folger, on February 16, 1884, gave Mr. Leonard Moody permission to purchase on Washington, Adams, and Johnson Streets a plot 175x235, for $408,500. The task was not an easy one, for the reason that selfish interests clashed with those of the government, and much valuable time and some money was wasted in foolish contestation.

The site finally selected is probably as eligible a one as could be found, and with the possible widening of Washington Street, the structure will have a prominence worthy of its architectural grace. It is purely renaissant in the style of its architecture. The tower will be at the corner of Washington and Johnson Streets, and it will have a frontage of 135 feet, a high basement, and Mansard roof.

The main cornice will be 75 feet from the pavement, and the tower will be 183 feet high.

It is believed that the Johnson Street front will be 235 feet. The post-office will occupy the basement and first story.—*Brooklyn Advance.*

THE NEW POST OFFICE, BROOKLYN, N. Y.

USEFUL DIRECTIONS FOR TAKING PORTRAITS INDOORS WITHOUT A SKYLIGHT.

By L. P. FERRIS.

To those amateurs not possessed of a skylight, the question of how to obtain a good indoor portrait is very puzzling, and has led to the spoiling of a great many plates and to the production of some hideous-looking faces, struck by lightning on one side and by midnight on the other. I propose in this article to give such directions as will enable any one who is skillful in outdoor photography to make a better portrait in an ordinary room than can be made in the open air. In fact, there is no reason why as perfect a portrait cannot be made in an ordinary room as in a "gallery," except the lack of skill on the part of the operator.

TO MAKE A BUST, CABINET OR HALF LENGTH.—LIGHT.

The first attempt is generally made in the room having the largest number of windows, all of which are opened to their fullest capacity, which only results in complete failure. The room preferable is one on the second floor or higher, and on the light side of the house. Close the blinds or lower the shades in such a way as to exclude the light from all windows but one. This window should be selected in such part of the room as will allow working space on both sides of it. A corner window with the side wall close to it is objectionable, for the reason that a background would be so near to the sitter that a shadow of the figure would be made upon it. Now, having the window open and the shade rolled all the way up, if there is sunlight or even a strong light upon it, darken the lower half by unhanging the shade (if convenient) and placing the roller upon the top of the lower sash. Allow the shade to fall to the sill, or hang anything over the lower sash that will exclude the light. If the subject is of very dark complexion, a piece of muslin would answer better than something opaque, as it would diffuse light over the face in addition to that obtained from above. If the clothing or drapery is very dark, it is well to obstruct the light from the lower sash just opposite the face and let it pass through below, so as to light up from the neck down; this will insure detail in the drapery. Never allow sunlight to fall upon any part of the sitter. If the sunlight is very strong at the

upper part of the window, a piece of cheese cloth or such light material may be placed over it, but not anything heavier. Now place a chair for posing the sitter about eighteen inches from the window, and so that the front of the seat is about one foot back of the line of the side of the window; this will bring the knees on a line with the side of the window.

Having seated the person, look at the head, and you will find the light falling strongest on the top, and at an angle of about forty-five degrees, *i. e.*, striking the forehead on the side toward the window and passing down toward the lower opposite side of the face, throwing the shadow of the nose upon the side of the upper lip; thus you have the skylight effect. When the eye becomes a little practiced, you will know whether a better effect is produced by moving the sitter a little forward or back—a little closer to the window or away from it. If a three-quarter face is to be made, the light may be strongest on the small side of the face by having it turned a little away from the window; this would be a "Rembrandt." If the light is wanted upon the larger side of a three-quarter face, then let it be turned a little toward the window. Always have the eyes looking straight ahead—not to one side. Place the sitter as far back on the seat of the chair as possible, then make a small roll of clothing, or take a thick book and place between the back of the chair and the back of the sitter, behind the shoulder blades. This will throw the chest and shoulders forward. Don't be deceived by the notion that a person must sit comfortably and "naturally" to make a good portrait. Of course, make him as comfortable as possible under the circumstances. Be sure to have the chin high enough and the line of the face (as shown against the background) perpendicular. Use a head rest or not, as you like; I never do, and seldom suffer for it. No one likes the sensation of having it against the head. If you are making a three-quarter face, let the body be square with the camera; if a full face, turn the body—preferably toward the window. If a profile, place the chest, shoulder, or even back toward the camera. All that I have said may be varied according to the taste and judgment of the operator. If the side of the face away from the window is too dark (which is almost always the case, place a sheet, or anything white, and about one yard square, in such a way (not nearer than three feet) as to reflect a little light upon this side of the face. The danger is of throwing too much light upon this side, making the face flat and destroying all contrast. Be careful to have the sheet held or placed in such a manner as not to be reflected in a large white spot upon the eye of the sitter.

POSITION OF CAMERA.

The camera should, of course, be placed close to that side of the room in which the window is located, so that a line from the lens to the sitter would be parallel with the wall in which the window is.

Raise the tripod so that the bottom of the camera is on a line with the top of the sitter's head, then incline the camera-front toward the subject so that the face on the ground glass is below a line drawn horizontally across the middle of the glass; the line should cross under the chin, or lower. Upon looking at the presentation upon the ground glass, it will be readily seen whether there is a good light upon the sitter or not. Focus upon the eye, the eyelashes if possible. Use about the medium-sized diaphragm, or $\frac{f}{8}$ to $\frac{f}{12}$ according to light.

BACKGROUND.

The most suitable background is something of a drab or light slate color, placed as already referred to, so far back as to prevent the possibility of a shadow of the sitter being thrown upon it. A window-shade of the right color makes a good background, or a piece of muslin coated with whitewash, to which a little lamp-black and glue have been added. Mix the lamp-black separately before adding to the whitewash.

The more rapid the plate, the better; expose from three to six times as long as out door, according to light; a long exposure followed by a slow development gives the best results.

GROUPS.

Groups of from three to eight persons may be made successfully in an ordinary room. Select a large window with the sun upon it, raise the shade, and place an ordinary sheet over the whole window. Place the group in the diffused light. If the light is not strong enough, open one more window and throw a small sheet upon the floor where the sun will fall upon it, but ordinarily it is better to use only one window. Use a little smaller diaphragm than for a portrait, and expose a "Diamond" or "Special" plate twenty seconds. Don't hurry the development. No background is necessary, but if the side of the room back of the group is of a light appearance, it is better than dark colors. With the above instructions the operator should reach success by a short route, and with less study and at less expense than it has cost the writer. I have not given reasons for all the suggestions above, as they would consume too much space. My experience has satisfied me that these directions followed with judgment will result in pleasing effects, and open a new field to many amateurs.

THE SEPARATION OF BROMIDE OF SILVER IN A GELATINE EMULSION.

FROM some recent experiments made by Dr. J. M. Eder, he has found that it is impossible to separate bromide of silver when mixed with gelatine absolutely from the latter. He used different chemical processes, but had the best success with Mr J. Plener's small centrifugal apparatus. It is caused to revolve with a speed of from 4,000 to 6,000 revolutions per minute. All the silver bromide is, by the action of centrifugal force, driven to the side of the vessel, and there forms a compact mass, from which the gelatine solution can be poured off clear, and the bromide of silver washed free from gelatine.

Bromide of silver that has been, by repeated separations in the centrifugal machine, and washings with hot water, completely freed from all soluble substances, contains, according to Dr. Eder's analysis, after drying at 150° C., some organic matter. One hundred parts of silver bromide contained, in one case, 0·45 and in another 0·52 part of gelatine. The experiment indicated that when bromide of silver has been precipitated in the presence of gelatine, it obstinately retains some of the latter, though the emulsion has been repeatedly treated by hot water and centrifugal force.

It was further deduced that if a coloring matter, such as eosine, was mixed with the emulsion, it would cling to the particles of bromide of silver in the same manner, and this fact was of considerable importance to those who were experimenting on the subject of "optical sensitizing."

Dr. Eder ascertained that if gelatino-bromide dry plates were immersed in a 10 per cent. solution of liquid ammonia in water for some minutes, and then dried, they appeared to be about twice as sensitive to white light as before, and yielded very intense pictures; they do not, however, keep very long. It was thought that the bromide of silver became crystalline, and that might have caused the increase of sensitiveness. When the film was dried after being dipped in the dilute ammonia solution, peculiar crystals formed on the surface.

PHOTOGRAPHY IN A BALLOON.

MR. GASTON TISSANDIER, in company with Mr. J. Ducom, has recently been making some experiments in photographing from a balloon, and the results obtained were highly satisfactory. The photographic apparatus employed was arranged upon the edge of the car in such a way as to pivot upon its axis, and to be kept in a vertical position, as shown in the accompanying figure. It consisted of what is called a tourist's camera, constructed by Mr. Mackensten. The objective was one of Francais's No. 4 rectilinear rapid ones of 14 inch focus, which was used with a 10 inch diaphragm, its aperture being 14 inches. The photographs were taken with a Francais shutter, and with a pneumatic and rubber spring drop constructed especially for the occasion. The time of exposure with this latter was $\frac{1}{15}$ of a second. The time might have been considerably reduced, but this does not appear to be necessary in aerostatic operations.

APPARATUS FOR PHOTOGRAPHING FROM A BALLOON.

The negatives obtained left nothing to be desired as regards sharpness and clearness of detail.

HOW NORWICH SHAWLS ARE MADE.

I WONDER how many of the elegant belles who have added so much luster during the past London season to the park and other fashionable resorts have ever given a thought to the weary fingers that worked the bewitching toilets which have so enhanced their charms, the weary heads that bent over their tasks, and the thousand and one stitches that were necessary to complete the whole?

This question was uppermost in my mind the other day as I watched the manufacture of one of those triumphs of design and manual skill, a Norwich shawl. When I had seen them complete and finished, I was struck, as every one must be, with the variety and brilliancy of their tints, and their minuteness of coloring; but it was not until I saw the process by which they are made that I at all realized the labor necessary to produce them, and the real beauty of their manufacture.

I wish I could give my readers a little idea of those shown to me before I commenced my tour through the work-rooms. The most beautiful of all was one made of the same design as the famous exhibition shawl of 1862. The center was pure white silk (all the shawls of which I am speaking are composed entirely of silk), the border of every conceivable tint blended together in the tiny patterns we are accustomed to see in Indian and Cashmere shawls; indeed, close beside it was one of the latter, which had been purchased for 150*l.*, in order to be of some use in designing. The value of this exhibition shawl was about 25*l.*, and its softness and elegance was beyond all praise, but it would be impossible in a mere verbal description to convey a fair notion of it. With this was another of a totally different character, but very handsome, similar to one of the three presented to the Princess of Wales on her marriage. It was composed entirely of black, red, and gold, one large uniform pattern quite covering it, without any distinctive center or border; a kind of shot ran through it, so that holding it up in a particular light you saw a rich crimson coloring, very like the reflection of sunlight peeping through crimson glass, as in the painted windows of our churches and cathedrals; indeed, the pattern of the shawl altogether had something rather ecclesiastical about it, reminding one of the cinquefoil decorations of the capital of a Norman pillar.

Another shawl similar to this last, only in blue, was presented to Her Royal Highness, and the design of the other of the three given to her was of such an elaborate description that if no other had been made like it, the one shawl would have cost over a thousand pounds. This, however, was not the case, and it is possible to get one for about 20*l.*; indeed, considering the tediousness and costliness of the manufacture, these Norwich shawls are not extravagantly expensive, costing from about 5*l.*; those at 10*l.* or 12*l.* are very handsome, and it seems strange that they are not more generally worn; but, notwithstanding constant rumors to the effect that shawls are coming in, they are still out of the fashion. The technical name for this, the most costly species of Norwich shawl manufacture, is "Flower." They are made of the very best silk imported, each importation being carefully sorted and the choicest portion used for the shawls, the rest for poplins and the variety of mixed fabrics for which the town is celebrated, such as mohairs, camlets, and all those miscellaneous specimens of manufacture, silk face and woolen backs, or wool interwoven with silk, which, truth compels me to add, are by no means famous for wearing well. The peculiar kind of crape made here is known by the name of "Norwich crape."

Norwich altogether is famous for all kinds of manufactures, but for the silk and woolen species it is indebted to the Dutch and Walloons who fled thither from the Netherlands when persecuted by the Duke d'Alba, in the time of good Queen Bess; she, with the wisdom for which she was famous, encouraged their settling here, and more than once visited the town in person. The result was a most beneficial one to the commercial prosperity of the town, and these good results were still further augmented by the subsequent settlement there of French Protestant refugees, who brought the taste for which their nation is celebrated to bear upon the works of plodding Dutch fingers.

But old days are making me wander from my recital of what I saw but recently. The first process of the manufacture presented to us was the manner in which the patterns were prepared for the loom. The original patterns were not unlike those used for Berlin woolwork. They were printed in colors, on tiny squares, each square representing a stitch; but whereas a square inch of work from a Berlin pattern would probably cover two or three inches of ordinary canvas, a square inch of the patterns printed for shawls would, when worked, be scarcely more than the twentieth part of an inch. From these printed patterns the cards are prepared for the loom. The cards themselves are long and narrow, about 6 inches by 3, and, by means of an ingenious machine round holes are punched out of these, in regular straight lines, each hole representing a stitch of the particular color for which they are intended. For instance, supposing that the design is a white lozenge on a red ground; in the line representing the apex of the white lozenge one hole would be punched for one stitch of white, in the next three, in the next five, and so on, declining again to one, the part not punched out representing the red part of the pattern. It is curious to watch how unerringly the woman at this machine seems to do her task, and as rapidly as possible, too. It is worked by a treadle, and at every movement of the foot the punch goes down, cutting out the desired number of holes, which is regulated by the fingers, acting on what reminded me very much of the keys of a concertina, three fingers pressed down giving three holes; two, two; and so on. The colored pattern is pinned up before the worker of the machine, who never seems to examine the cards; when finished, though, as she told me, she never hardly made a mistake. Should a hole, however, be wrongly punched, there are morsels of card ready at hand to insert in the aperture. One pattern would make any amount of articles, but if duplicates are required, the cards are copied by a newly-invented machine, which requires no tedious reference to the colored pattern, merely duplicating the holes. The cards are next tightly laced together with string, longitudinally, so that, divided as they are into such small divisions, they are perfectly flexible and ready for use.

My next visit was to the winding-room, where the large rough skeins of silk are neatly wound on to wooden reels or bobbins by means of revolving winders, either turned separately, by the hand, or all together by a steam-engine. This affords constant employment to a number of girls, who either turn the winders or attend to the silk itself, which now and then does not go as smoothly as it ought; indeed, they require constant attention to prevent the silk being wasted.

From these reels or bobbins the silk is again rewound by a most ingenious process—which keeps each infinitesimal thread quite distinct from its neighbors—on to a large revolving-machine 7 or 8 feet high and 5 or 6 feet in circumference, which reminded me more of those large turngates at the Zoological Gardens than anything else. A variety of colors can be rewound on this and kept totally distinct, whence they can be transferred to the shuttle, or to the loom itself, for the warp.

All the looms used for the manufacture of these shawls are the old "Jacquard" looms, worked entirely by hand. The cards serving as patterns hang down the outer side and pass into the loom as they are required, communicating with a vast quantity of twine threads suspended from the top. The man who works it sits on a raised seat in front of the loom, very much as one sits at a piano, the work as completed rolling round a roller next to him, but protected from any contact with his working clothes by a thick covering of brown paper. One of the things that struck me most was how such delicate fabrics as I had seen could be kept so clean and spotless in the necessary dirt and dust of a manufactory, and the continuous contact with the loom.

The warp extends the length of the machine before the worker, being apparently divided into two, the upper and the lower threads, the upper raised some inch or so above the lower during the progress of the work, but eventually drawn together by the cross-threads when completed. The warp is of one color, save in case of shots, and then it is of two. The variety of color is formed by the cross-threads, which are passed along by shuttles, each shuttle containing a different color. There are four or five shuttles on each side—at least in the loom where, according to technical phraseology, the exhibition shawl was "set up," and as the bordering of this was very elaborate, with apparently every color of the rainbow in it, there were as many colors required as are ever used.

The loom is worked by a treadle, and the various shuttles required are passed across and selected by the

workman—according as the holes in the card pattern act on the loom—by means of a stick or handle, which hangs in the middle attached to a cord. This he manipulates with a good deal of workmanlike skill, though to an uninitiated spectator he appears to be acting without any guide, for the cards are too far away from him to be within his ken. I had expected to see a large colored pattern pinned up before him, but there was nothing of the kind. Great care is, however, needed, for one thread in the wrong place would spoil the whole fabric; this we can easily realize. What should we say if we saw a bright red or blue thread running across a pure white center? And this would be the effect if the slightest error occurred. A shawl of the elaborate pattern I saw in progress would take from a fortnight to three weeks to make, and certainly whatever care and toil is bestowed upon them, they well repay it.

I have attempted to describe the manufacture of the most costly kind of shawls Norwich produces, which are made in the same way exactly and on the same loom as many of the figured neckties gentleman wear. There are several kinds of Norwich shawls—wool and silk and wool alone—all made after the same fashion, but more or less elaborate.—*Sanitary World.*

THE MECHANICAL PRODUCTION OF COLD, AND THE EFFECTS OF COLD UPON MICROPHYTES.*

By J. J. COLEMAN, F.C.S., F.I.C., and Professor J. G. MCKENDRICK, M.D., LL.D., F.R.S.

THIS discourse was delivered by Mr. J. J. Coleman, and embraced two parts, viz., first, a description of his own researches and their application in the construction of cold-producing machines; and second, a description of a joint research undertaken by Prof. McKendrick and himself upon the effects of very low temperatures upon microphytes.

Mr. Coleman pointed out that in the first place the title of the discourse might be objected to, inasmuch as it was scarcely correct to speak of the "production of cold." As, however, long usage had made the phrase conventional, it would be used in the sense of meaning production of a state of coldness.

A close examination of all known methods of producing cold by artificial means involved the employment of some voltaic liquid or compressed vapor capable of spontaneously expanding. Thus, commencing with water, its spontaneous evaporation produced the state of coldness of the domestic water cooler.

The evaporation of ether, as in the spray used by surgeons; also the evaporation of liquid sulphurous acid, which boiled at —10° C.; of liquid carbonic acid, which boiled at —78° C.; of liquid nitrous oxide, which boiled at —86° C.; of liquid ethylene, which boiled at —102° C.; or of liquid air, which boiled at 191° C., were all perfectly analogous to the spontaneous expansion of compressed air, when released from pressure by opening the cock of a vessel containing it.

The nearer the compressed vapor is to the state of a perfect gas, or of a hypothetical perfect gas, the more exactly is the heat absorbed by expansion balanced by the heat generated by the friction of the molecules before coming to rest. This followed from the joint researches of Sir William Thomson and Dr. Joule, conducted thirty years ago.† These eminent men, in a classical series of experiments, the description of which occupies 122 pages of Sir William Thomson's researches and involved upward of 1,000 observations collected in 50 tables, demonstrated among other things that air having a pressure of 100 lb. per square inch, when passed through a porous plug so as to reduce its pressure to that of the atmosphere, only becomes cooled to the extent of 1·6° C., hydrogen gas similarly expanded being heated 0·116° C.

Free expansion of atmospheric air under pressure through a small orifice of any kind was similar in its results, which Mr. Coleman demonstrated by expanding a cubic foot of air of several atmospheres pressure into a glass reservoir or chamber containing a delicate air thermometer, which was not in the least affected, although the result was thrown upon the screen magnified and illumined by a beam of electric light.

It was otherwise, however, when the experiment was made as originally conducted by Guy-Lussac and Dr. Joule, in which case the vessel containing the air being expanded became cold, and the vessel into which the air flowed became hot, the one phenomenon neutralizing the other.

Mr. Coleman showed by an arrangement of his air thermometer, the index of which was projected upon the screen, that the vapor which exists in an ordinary bottle containing a little liquid ether has sufficient tension to cause friction and production of heat in escaping through a narrow orifice.

In this case the heat abstracted from the evaporating liquid was compensated by the latent heat absorbed in conversion of the ether liquid into ether gas + the heat caused by the *vis viva* of the escaping molecules coming into contact with the walls of the orifice and afterward with the external atmosphere.

The apparatus used was called a "Tripatmoscope," and was constructed as follows:

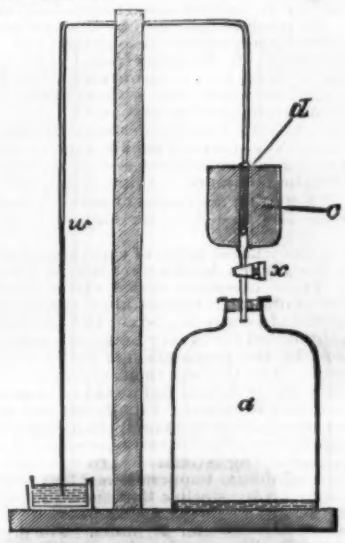
a is a bottle of say one-fifth of a cubic foot capacity containing a small quantity of liquid ether, and into the neck of which was fitted by an India rubber cork a glass funnel; *c* is a plug of boxwood cemented into the funnel bowl, and having an annular aperture barely sufficient to admit the thin copper cylindrical bulb, *d*, of an air thermometer, say ½ inch diameter and six inches long, and packed tight into the boxwood by making the bulb a little sticky with mastic varnish and winding round it fine cotton thread. On opening the cock, *x*, at intervals of a few minutes, a marked fall of the water index, *w*, occurred, which was magnified and illumined by a beam of electric light, indicating nearly 1° F. produced by friction of escaping vapor.‡

The statement that is met with in some text books, that no cold can be produced by expanding air without *mechanical work* being performed, is not strictly correct, as one fraction of a given volume of air can be cooled by blowing the other fraction into the atmosphere; but all such methods of producing cold are, however, from an engineering point of view, wasteful; for to make an economical machine energy must be abstracted from the expanding medium (generally in the form of mechanical power, but not necessarily, as for instance in the ammonia absorption machine) before the *whole* volume of the gaseous medium can be reduced in temperature; and not only is this necessary, but in order to enable the medium, when it has arrived at atmospheric temperature, to be employed for a fresh cycle of operations, energy must be introduced and then rejected.

In the case of atmospheric air, the energy used in compression appears as heat every cycle which has to be rejected, and this is accomplished either by washing the air with injected water or by passing it through tubes surrounded by water.

Some idea of the heat required to be removed each cycle is afforded by the fact that compression of air to the extent of 65·86 lb. per square inch above the atmosphere increases its temperature by 332° F.

It is now about five years since machinery of this kind came into extensive use, and for a long time there was a curious controversy among engineers as to the two methods of removing the heat produced by compression. It was maintained that the water injection would wet the air, but the lecturer showed by expanding a cubic foot of air at 100 lb. pressure per square inch standing over water in the theater of the institution that, on emerging from the iron bottle containing it, it was exceedingly dry, which indeed followed from the fact discovered by Dalton that saturated vapor is liquefied by compression at a constant temperature, in direct proportion to the degree of compression. In practice, however, especially at sea, the air pressure is kept about 50 lb., and the dryness of the air is further insured by passing it, on its way to the expansion cylinder, through an interchanger, around the outside of which the partially cold air flowing to the compressor is made to circulate.



A number of large diagrams and a complete model were shown, showing the general construction of the cold-air machines used for importing meat into Great Britain, all of which were now manufactured after the general designs introduced by the lecturer a few years ago, and described to the Institution of Civil Engineers in his paper read there in February, 1862.

By means of these machines, Australian, River Plate, and New Zealand mutton comes into Great Britain at the rate of 18,000 sheep, or 400 tons, per week, which represents a weekly procession a mile long and ten abreast. The quantity of American meat carried by the machines is still larger, so that the British householder is now supplied with them by meat to the value of between £4,000,000 and £5,000,000 *per annum*, calculated at the price of meat in retail shops.*

These machines, in an ordinary way, supply streams of atmospheric air, cooled to about 80° below zero F. (—63° C.), but by certain modifications they can be adjusted to deliver the air cooled much lower, and, in point of fact, to as low temperatures as have yet been produced in physical researches.

For the purposes of the conjoint experiments with Prof. McKendrick, a machine, worked by a gas motor engine, capable of delivering 30 cubic feet of air (0·84 cubic meter) per minute was employed, the cold air being made to pass upward in a square vertical shaft of wood, in the sides of which were apertures regulated by valves, and by means of which about a dozen chambers, each of three cubic feet capacity (0·084 cubic meter), could be maintained at any particular temperature desired. These temperatures were carefully taken by an absolute alcohol thermometer, made by Negretti and Zambra, and checked by a special air thermometer devised by Mr. Coleman.

The experiments consisted in exposing for hours to low temperatures putrescible substances in hermetically sealed tins or bottles, or in flasks plugged with cotton-wool; the tins or flasks were then allowed to thaw, and were kept in a warm room, the mean temperature of which was about 80° F. (27° C.); they were then opened and the contents submitted to microscopical examination with magnifying powers of from 250 to 1,000 diameters. The general results were as follows:

1. Meat in tins 4¼ inches in diameter and 1 inch in depth, exposed to 80° below zero F. (—63° C.) for six hours, underwent putrefaction with generation of gases.†

2. While these experiments were going on, comparative experiments were made with tins and bottles containing meat, but not exposed to cold. Under such circumstances the effects of storing them in the warm room for even the short period of a fortnight was to develop such large quantities of extremely fetid gas, and very active bacteria and vibrios, that there was no doubt whatever but that exposure to a cold of 80° below zero (—63° C.) had checked their development to some extent in the subsequent exposure to a warm temperature.

3. On the 24th of December, 1884, thirty samples of fresh meat were placed in two-ounce white glass vials. These were carefully corked with corks previously steeped in mastic varnish, and the necks of the corked bottles were then immersed in melted sealing wax. These bottles were divided into five sets, and marked A, B, C, D, and E, and they were treated as follows:

A.	6 samples were exposed to zero F. (—17° C.)		65 hours.	
B.	6	"	—20° F. (—29° C.)	"
C.	6	"	—30° F. (—34° C.)	"
D.	6	"	—40° F. (—40° C.)	"
E.	6	"	—80° F. (—62° C.)	"

These experiments ended on 28th December. On the 29th one bottle from each group was again exposed to —80° F. (—63° C.) for six hours, then again frozen for six hours at —80° F. (63° C.). The whole of these were removed to the room, but in the mean time it was noticed that at temperatures below zero, and particularly so low as — 80° F. (—63° C.), the meat assumed a peculiar dirty-brown appearance. In the course of a few hours, however, the whole of the samples assumed at normal temperatures the well-known reddish color of meat. In all cases, however, in the course of ten or twelve hours after removal to the warm room, signs of putrefaction were visible, and in the course of a few days the putrefactive process was fully established. It is important to notice that the temperature reached in these experiments, namely, from —70° to —80° F. (—56° to —63° C.), is about the minimum degree of cold hitherto observed in polar expeditions.*

4. It is well known that freezing muscle taken from a newly killed animal prevents the coagulation of muscle plasma, and that the plasma can, on partial thawing, be squeezed out of the muscle and allowed to coagulate. It occurred to the lecturers that if muscle were suddenly exposed to extreme cold, before cadaveric rigidity had set in, some change might be observed in the putrefactive process. Accordingly a rabbit was instantaneously killed, portions of its muscles were at once placed in stoppered bottles, and transferred to the cold chamber, then having a temperature of about —80° F. They were kept there for ten hours; then allowed to thaw partially in the cold chamber, while the cold-air machine was not at work; then again frozen for 12 hours; and finally transferred to the warm room. In these circumstances they underwent rapid putrefaction. The samples seemed to be more moist than other specimens of ordinary butcher meat, and they certainly underwent more rapid putrefaction.

5. A further set of experiments with meat was carried out, in which the samples were continuously exposed to a temperature of from —90° to 120° F. (—83° C.) for 100 consecutive hours; the bottles were then removed to the warm room, with the result that in ten or twelve hours the putrefactive process seemed to be fully established.

5 *a*. It has been shown by Pasteur† that if putrescent or fermenting substances are sealed up in a comparatively small space containing air, the processes are arrested when all the oxygen has been used up, and the products of putrefaction may undergo no further alteration. In these circumstances, in such experiments as ours, the apparent arrest of putrefaction in sealed vessels might have been attributed to the action on the organisms of the low temperature to which they had been exposed, instead of to the real cause —the removal of all the oxygen from the confined air. To meet this difficulty, the importance was seen of testing the effect of cold on putrescible substances placed in test-tubes and flasks firmly plugged with cotton-wool, through which there might be a free play between the gases in the tube or flask and the surrounding atmosphere. Nor was it necessary in such experiments to sterilize the cotton-wool by heat, as must be done in all researches on the effects of high temperatures, because if a low temperature were fatal to microorganisms, it would kill those in the cotton-wool as well as those in the putrescible substances. Many experiments were made with tubes and flasks stopped with cotton-wool plugs instead of being hermetically sealed, but there was no difference in the general result.

6. Six flasks were filled with fresh urine, and plugged with cotton-wool, on the 10th of December. The first one plugged with wool was exposed to the temperature of the engineering shop where the experiments were carried on (about 50° F.), and on the 13th the urine was muddy; on the 18th it was found to be swarming with bacteria and vibrios. The second was exposed for eight hours to zero F.; on the 13th it showed slight muddiness, and on the 18th it was swarming with bacteria. The third was exposed to a temperature of —10° F. for eight hours, and on the 18th it was also swarming with bacteria. The fourth was exposed to —20° F. with the same result. The fifth was exposed to —30° F., with a like result. The sixth was exposed to —80° F., and it did not become muddy until the 23d, that is, twelve days after the beginning of the experiment. These results showed that freezing at very low temperatures delayed the appearance of the alkaline fermentation due to organisms, but a temperature of —30° for eight hours did not sterilize the urine.

7. Samples of fresh milk, exposed to temperatures of from zero to —80° F. for eight hours, curdled, and showed the well-known *Bacterium lactis*, and so far as could be observed, freezing did not delay the process after the flasks were kept at a temperature of about 50° F.

---

* A Lecture delivered before the Royal Institution of Great Britain, May 29, 1885.—*Chemical News.*

† "On the Thermal Effects of Fluids in Motion." See collected papers of Sir W. Thomson, vol. i., Cambridge University Press, 1882.

‡ This instrument works best in an atmosphere of about 70° F., but with a slight occasional agitation of the liquid ether gives good results at 60°.

* According to the Smithfield Market reports, 27,007 tons of mechanically cooled meat arrived from U. S. America in 1884, and 5,900 tons Australian, New Zealand, and River Plate frozen mutton in first three months of 1885.

† July, 1885. At this date, which is eight months from the commencement of the experiment, several of the sealed-up tins are on hand; the bulging of the tins and apparently the generation of gases ceased after the first month, the organisms being apparently rendered inactive by their own effluvia, or from want of oxygen. There is now very little smell on opening the tins, but a large number of organisms are visible with a one-eighth inch object glass—alive and active.—J. J. C.

* The lecturers have been favored with the following remarks by Mr. Alexander Buchan, the eminent meteorologist, to whom they applied for information: "So far as I am aware, or can discover, the temperature of —73·7° F. registered on board the Alert in March, 1876, is the lowest temperature yet observed anywhere in the free atmosphere. The lowest mean monthly temperature known is —55·8° F. for January, at Werchojansk (lat. 67° 34′ N., and long. 133° 51′ E.), in northeastern Siberia." It is possible that one or more of the individual observations that make up this low mean may have given a reading lower than —73·7° F.

† *Comptes Rendus*, lvi., 734–1189. See also article "Fermentation," Watts's "Dictionary of Chemistry," First Supplement, p. 512.

8. Samples of Prestonpans beer (containing about 2 per cent. of alcohol) were similarly treated. Exposed to the air of the shop, a scum of torulæ made its appearance in three days. Freezing undoubtedly delayed the appearance of these in flasks plugged with cotton wool, and the delay corresponded to the fall of temperature, so that the sample exposed to —80° F. did not show the scum for twenty-two days after its removal from the cold chamber. Still, it could not be said that this degree and duration of cold sterilized the fluid.

9. Samples of sweet ale behaved in a precisely similar manner.

10. Samples of meat juice, made by boiling lean meat, filtering, and carefully neutralizing, were also operated on, both in flasks hermetically sealed and having the necks stuffed with cotton-wool. Exposed to temperatures of from zero to —80° F. for eight hours, all of these in due time showed, under the microscope, numerous bacteria, but the freezing process undoubtedly delayed their appearance, and this was most marked in the samples exposed to the lowest temperatures.

11. Samples of neutralized vegetable infusion behaved in a similar way.

12. Many experiments were made with putrefying fluids, full of bacteria and other micro-organisms. The method followed was to examine the fluid with the microscope, and to note the appearance of the organisms. Then portions of the fluid were placed either in a flask plugged with cotton-wool or in a hermetically sealed flask, and exposed to the lowest temperature attainable, namely, —120° F. In one set of experiments such organisms were exposed to —120° F. for 100 consecutive hours. The thawed fluid was again examined microscopically, with the result of showing that the organisms were motionless. Still, it could not be asserted that they, or at all events their spores, were dead, as, after exposure to a temperature of 80° F. for a few hours, the fluid was found to be again teeming with organisms in active movement. The conclusion arrived at was that such prolonged exposure to cold did not kill them all, probably leaving spores unaffected.

13. It was also attempted, by *repeated* freezings and thawings, to kill micro-organisms, as it was conceivable that cold might kill the adults only, leaving the spores unaffected. If, then, the spores were killed as they approached maturity, and before they had produced new spores, it might be possible to sterilize the fluid. All attempts in this direction were unsuccessful.

14. Experiments were also made with gelatinous infusions of meat, to which grape sugar had been added. Exposure to low temperatures and thawing did not destroy the gelatinous character of the substance, but putrefaction was not prevented. Such gelatinous masses, after exposure for 100 consecutive hours to —120° F., and subsequently for fifteen to twenty hours in a warm room of 80° F., became filled with bubbles of imprisoned gas, each bubble being the outcome of one or more organisms.

15. It is a striking consideration that freezing at low temperatures makes a mass of organic matter solid throughout, so that it can only be broken to pieces by violent blows of a hammer. Beef has then a fractured surface like a piece of rock. Mutton is friable. Still, when such a mass—say a piece of muscle—is thawed, its microscopical structure seems to be unaltered. All that can be said is that it is moister than ordinary fresh muscle. It is probable, therefore, that the bodies of micro-organisms are also frozen solid, and yet they apparently may live for a long time in this condition. One cannot suppose that in these circumstances any of the phenomena of life take place; the mechanism is simply arrested, and vital changes may again occur when the conditions of a suitable temperature return. Such considerations led the lecturers to examine whether any of the vital phenomena of higher animals might be retained at such low temperatures. It was ascertained that a live frog may be frozen quite solid throughout at a temperature of from —20° F. to —30° F. in about half an hour. On thawing slowly, in two instances, the animal completely recovered. When kept in the cold chamber longer than half an hour the animal did not recover, but the muscles and nerves were still irritable to electricity, responding to weak induction shocks. Reflex action, however, was abolished. In two cases frogs were exposed for twenty minutes to a temperature of —100° F. On thawing they did not recover, but the muscles still feebly responded to electrical stimulation, showing that their irritability had not disappeared. The probability is that longer exposure to this temperature, or exposure for a shorter time to a lower temperature, would destroy muscular and nervous irritability; but it is a striking fact that irritability can survive to any degree a transition through a state of solidity produced by cold.*

16. One experiment was performed on a warm-blooded animal—a rabbit. Before the experiment, the temperature of the rectum was 99·2° F., pulse 160 per minute, respirations about 45 per minute. At 10.30 a.m. it was placed in the cold chamber, the thermometer of which stood at —93° F. At 11 a.m. it was removed for a minute or two; it did not seem to be affected, but the temperature of the rectum was now 94·2°, a fall of five degrees in half an hour. It was then reintroduced into the cold chamber, the temperature of which was read off at —100° F. It was taken out at 12 noon; it seemed to be comatose; reflex action was abolished; there were jerking movements of the limbs; its rectal temperature was now 43° F., a fall of 51° during the hour; its pulse was 40 per minute, being a fall of 120, and its respirations were barely perceptible. It was placed in a warm place, and it began slowly to recover. In fifteen minutes its temperature had risen to 72° F., in ten minutes more to 89° F. Its pulse beats when removed from the chamber were 40 per minute, in 15 minutes they had risen to 60 per minute, and in fifteen minutes more to 100 per minute. The animal completely recovered. When removed from the chamber at 12 noon, although reflex action was abolished, the muscles were still irritable to electrical stimulation, and on placing the wires over the sciatic nerve without cutting the skin, strong spasms of the muscles of the leg were caused, showing that the nerve was still irritable. It follows therefore that some of the effects of the extreme cold were due to the inactivity of the nerve centers. Consciousness and reflex action were abolished, owing to inactivity of the gray matter of the encephalon and of the spinal cord.

The effect of the extreme cold on the warm-blooded or homoiothermal animal, as contrasted with its effect on the cold-blooded or poikilothermal animal, is very striking. The cold-blooded frog became as hard as a stone in from ten to twenty minutes, and the temperature of its body was probably the mean temperature of the chamber; the warm-blooded animal produced in itself so much heat as enabled it to remain soft and comparatively warm during exposure of an hour's duration to —100° F. Still, its production of heat was unequal to make good the loss, and every instant it was losing ground, until, at the end of the hour, its bodily temperature had fallen about 56° F. below its natural temperature. Had it been left in the chamber long enough, its bodily temperature would have fallen until it reached the temperature of the cold chamber, and it would then have become as hard as the frozen frog. It is remarkable, however, that even at the end of an hour's exposure to —100° F., its bodily temperature was 143° above —100° F. As bloods freezes and the hæmoglobin crystallizes at about 25° F., had the temperature of the body fallen below that point, the animal would not have recovered, as its blood would have been destroyed.

The lecturer observed that several researches had been made prior to those of himself and Professor McKendrick on the influence of cold, none of them, however, very decisive as regards the microphytes concerned in the putrefactive processes. Thus before 1872 we find Dr. Ferdinand Cohn† stating that he had subjected bacteria to low temperatures without destroying their activity. He gives the temperatures as follows: Exposure for twelve hours thirty minutes to a temperature of 0° C.; for one hour thirty minutes to — 16° C.; for one hour forty-five minutes to —17° C.; for three hours thirty minutes to —18° C.; for four hours thirty minutes to —18° C.; for five hours to 17·5° C.; for six hours to —14° C.; and for seven hours thirty minutes to —9° C. He produced the cold by freezing mixtures, and the lowest temperature he obtained was —18° C. =0° F. In 1870-71, M. Melsens exposed yeast and vaccine lymph to very low temperatures (—78° C.), by means of solid carbonic acid, without destroying the power of fermentation or inoculation.†

Klein‡ states that "freezing destroys likewise most bacteria, except the spores of bacilli, which survive exposure to as low a temperature as —15° C., even when exposed for an hour or more." Again, in another place,§ he says: "Exposing the spores of anthrax-bacillus to a temperature of 0° to —15° C. for one hour did not kill them."

In 1884 a remarkable series of experiments were described to the French Academy by MM. R. Pictet and E. Yung.‖ These observers sealed up in small glass tubes fluids containing various kinds of microphytes, and placed them in a wooden box. The box was in the first place submitted for twenty hours to a cold of —70° C., produced by the evaporation of liquid sulphurous acid *in vacuo*. The box was then surrounded by solid carbonic acid for 89 hours, and a cold of from —70° to —76° C. was thus obtained. Finally the box was subjected for a third period of 20 hours to a cold produced by the evaporation of solid carbonic acid *in vacuo*—the temperature being estimated at from —76° to —130° C., that is, a minimum temperature of 202° below zero F. They sum up by stating that the organisms were acted on by a cold of —70° C. for 109 hours followed by a temperature of —130° for 20 hours. The organisms tested were *Bacillus anthracis*, *Bacillus subtilis*, *Bacillus ulna*, *Micrococcus luteus*, and a micrococcus not determined. *Bacillus anthracis* retained its virulence when injected into a living animal. The vitality of the others was not affected. Experiment showed that, while cold seemed to kill some of the micrococci, a great number resisted it. Yeast showed no alteration under the microscope, but it had lost its powers of fermentation. Vaccine lymph exposed to the low temperatures did not produce a pustule on the left arm of an infant, while another sample of the same lymph introduced into the right arm of the same child produced a pustule. Pictet and Yung conclude from their experiments that, in the conditions of cold indicated, many of the lower organisms were not destroyed.¶

From this consensus of evidence, Mr. Coleman observed, it then appears that any hope of permanently sterilizing meat by cold (the counterpart of Appert's process by heat) must be abandoned, but it is quite possible that at some point near absolute zero the vitality of all microphytes may be destroyed.

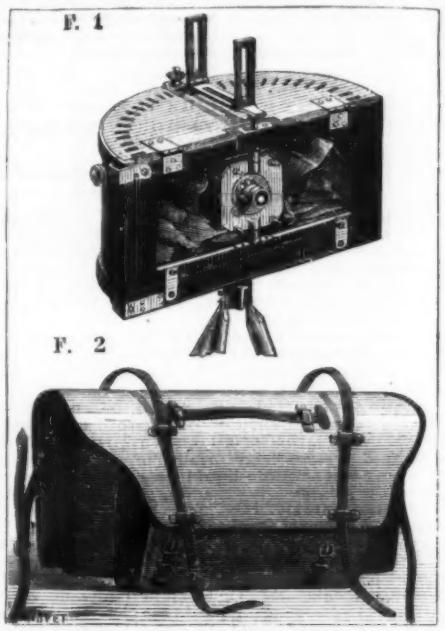
The persistency, however, of their vitality between great extremes of temperature, ranging in fact through 400° F., is very remarkable, and is in marked contrast to their susceptibility to destruction by moist ozone, peroxide of hydrogen, and by sunlight or diffused daylight.**

There can be no doubt about disease germs being pestiferous, but it is quite possible the function of many microphytes is beneficent, preventing the undue accumulation of dead organic matter, though it is not quite clear that they are absolutely essential as a preliminary to its oxidation, and on this and kindred subjects there is much work yet to be done by the united labor of the physicist, chemist, and physiologist.

THE CYLINDROGRAPH.

CAPT. MOESSARD, professor at the Military School of St. Cyr, is the inventor of a new panoramic photographic apparatus, which, through a simple rotation of the objective, permits of obtaining a cylindrical perspective of surrounding objects. It may be easily used for making reconnaissance surveys and topographical maps.

The angular aperture of this apparatus is capable of an amplitude of about 170 degrees. Two contiguous negatives, taken from the same point, may, then, embrace a total of 340 degrees, say at about 20 degrees a complete panorama of the station selected by the operator. The construction of this ingenious instrument, which is called the "Cylindrograph," is based upon the experimental fact that the lens of a photographic objective may have any motion whatever without the image furnished by it and caught upon a screen changing either form or position, on the sole condition that the said motion takes place around the *back nodal point*, kept immovable. This fact results from the well-known property that this point possesses of being the real meeting or virtual point of the emergent secondary axes, or the point of view of the perspective produced.



FIGS. 1 AND 2.—THE CYLINDROGRAPH AND ITS BAG.

Let us suppose any photographic objective whatever to be fixed horizontally, and capable of revolving around a vertical axis through its back nodal point; two vertical shutters fixed behind to the right and left of the objective, in order to limit the field in a horizontal direction and to arrest the two oblique rays; and a vertical cylindrical screen centered upon the axis of rotation, and of a radius equal to the distance from the nodal point to the principal focus of the objective. In such a system as this, whatever be the position occupied by the objective, that portion of the landscape embraced in the field of the apparatus will be delineated upon the screen. If, then, we set the objective in motion, we shall obtain in succession, for each point of the panorama, an image that will make an impression upon the sensitized film during the time that the point remains in the field limited by the two shutters.

Such is the theoretical principle of the cylindrograph, an apparatus that may be briefly described as follows:

The instrument consists essentially of a semi-cylindrical camera obscura formed of two semicircular plates—top and bottom—connected according to their diameters by a rectangular frame (Fig. 1). For the sake of ease of carriage these three parts can be folded upon each other, since they are hinged along the edges of the top and bottom. In the center of the frame is mounted the rotary axis, which carries the objective and shutters. The space between the objective and frame is closed by a piece of opaque cloth. The bottom of

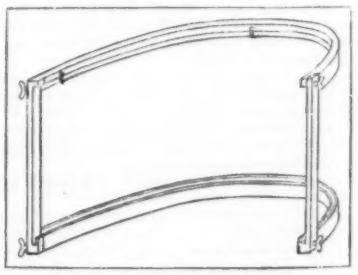


FIG. 3.—THE FRAME.

the camera is occupied by the negative frame containing the sensitized film (Thiebaut's make). This frame is rectangular, and of an elastic material—celluloid. Although flat during carriage, it is capable of assuming a cylindrical shape at the moment of exposure. The bottom of it consists of a piece of opaque cloth, while the front is closed by a movable curtain. Seventeen frames are sufficient for any one who is to take eight complete views of the surrounding horizon.

The desired rotary motion is transmitted to the axis by means of an alidade provided with sights through which the operator can see everything that the field of the instrument embraces. This alidade can be actuated by clockwork, or, better still, by hand, since the latter method permits of moderating the rotary velocity at will, and consequently of varying the time of exposure, according to the nature and illumination of the objects to be taken.

* Kühne observed that a frozen frog's muscle will contract after thawing, but the temperatures he reached were not low.

* Cohn's *Beitrage zur Biologie der Pflanzen*, 1870, Zweites Heft., p. 221.

† Melsens, *Comptes Rendus*, tome lxx., 1870, p. 629; also tome xxi., p. 325.

‡ Klein, "Micro-organisms," p. 35.

§ Klein, *op. cit.*, p. 73.

‖ *Comptes Rendus*, tome xcviii., No. 12 (24 Mars, 1884), p. 747.

¶ In a letter to Dr. McKendrick, Professor Arthur Gamgee states that some months ago he exposed putrescible fluids to moderate degrees of cold without thereby preventing putrefaction, and that he abandoned the research as unlikely to lead to any important result with the temperature he had at command. It is also stated in Landois's "Physiology," translated by Stirling, vol. i., p. 456, on the authority of Frisch, that "bacteria survive a temperature of —87° C.; yeast even —100° C."

** "Researches on the Effect of Light upon Bacteria and other Organisms," by Arthur Downes, M.D., and J. F. Blunt, M.A., *Proc. Roy. Soc.*, xxvi., 1877.

There are various devices for regulating the position of the objective upon the axis, for measuring the rotary velocity, for keeping the cylinder vertical, and for marking upon the negative the magnetic position, the horizon line, and the angular aperture of the view taken. All these arrangements are very simple, and their mechanism extremely convenient.

Folded up as above described, the camera, along with twenty frames, can be put into a small bag that may be carried by hand or swung over the shoulder (Fig. 2). The weight of the bag thus filled does not exceed eleven pounds, inclusive of the sliding tripod. The apparatus is therefore very portable, and consequently adapted for making military reconnaissances.

As may be conceived, when a cylindrical perspective is spread out upon a plane, certain disfigurations are observable that take from the cylindrographic views their true character. The use of the *cylindroscope* permits of obviating this difficulty.

This accessory apparatus consists of a semi-cylindrical wooden frame, whose semicircular bases are connected by nuts with two uprights. The four pieces fold up, when necessary, in the same plane, for the sake of ease of carriage. One of the semicircles carries a groove, and the other an external flange and three free tourniquets. It is easily seen how there may be introduced into this little frame cylindrographic positives that have been previously mounted upon Bristol-board. These plane positives are, in fact, bent upon the perspective cylinder. After this, when we look at them from the center of the apparatus, we find a complete restoration of the objects considered—the image, in its entirety, bearing the impress of the seal of truth. The effect produced is still more remarkable than that observed in a flat picture. These cylindrographic perspectives furnish valuable data for use in deducing the topographic elements of the land, that is to say, the azimuth of a point and the slope to the right which, in space, connects such point with the station point. It is possible, through the use of two simple scales, to construct such a tour of the horizon as would have been given by any other proper instrument. In assembling such tours we have merely to take one measure of length in order to determine, by intersection, as many points as we desire.

This mode of operating possesses great advantages over the methods that require the use of the plane-table and eclimeter. A panorama is obtained effectively in a few minutes by means of a series of *quasi* mechanical operations that require no multiplied sightings, nor drawings, nor sketches, nor any of those plottings that it is so difficult to make in the open air. We are not occupied with delicate points, nor minute readings, nor prolonged researches. We do not have to fear that we shall forget such or such an important point, since all that is visible of the station is delineated upon the film. Nor does office work present any more difficulty. The constructions to be made are very simple, and it is impossible to commit errors in direction, level, or bearings.

On another hand, we have a number of means of verification that serve at every moment to control the accuracy of the results obtained. Maps that are drawn from the data furnished by the cylindrograph leave nothing to be desired as regards fidelity and precision. Moreover, the collection of photographs obtained upon the ground remains to aid cartographic work, and the latter loses its stiffness when it is accompanied with a selection of general views that brings out the character of the country represented.

There is one inconvenience to be pointed out, which is more apparent than real, and, at all events, not of much account. The process mentioned seems to require on the part of the operator a certain experience in the art of photography, for the sake of conducting the operation in the camera correctly, the developing of the image and the printing of the positives. But, in order to be topographically utilizable, the photographs have no need to be of great artistic value; moreover, such progress has been made in the manufacture of and mode of using sensitized plates that the art may be said to be now within everybody's reach. Presented by Col. Perrier the Moessard cylindrograph obtained the approbation of the Academy of Sciences, and we are persuaded that it will interest our readers.

OPTICAL TELEGRAPHY.*

DESCRIPTION OF THE PORTABLE OPTICAL APPARATUS.

THE campaign optical apparatus consists essentially of the following parts: (1) of an emission objective; (2) of a manipulator; (3) of a telescope for receiving the signals; and (4) of a kerosene lamp with flat wick, to be used in cases of failure of solar light. The whole is supported by a tripod.

The luminous fascicle emitted by the source, S (here a kerosene lamp), is directed into space by the emission objective, MM', NN', in the principal focus of which is placed the said source (Fig. 12). The small mirror, P, which is placed behind the lamp, and the center of whose curvature coincides with the center of the flame, is designed to send the light that it reflects through the flame itself, and thus re-enforce it.

* Continued from page 8081.

The Manipulator.—At about 3 or 4 inches in front of the focus, S, there is a sheet iron partition, EE', containing a circular aperture, *cc'*, whose diameter is so calculated as to be slightly larger than that of the section of the luminous fascicle, which at this point is conical. Between this partition and the lamp moves the manipulator, AA'. This consists (Fig. 13) of a screen, F, of striated aluminum actuated by a small lever and pedal, G, upon which pressure is exerted in order to move it, and which is pulled back by a counter-spring, R. Upon depressing the pedal we uncover the aperture, *cc'* (Fig. 6), and allow a beam of light to pass. When the spring, R, pulls back the lever, the screen, F, closes the aperture again. In this manner we obtain in luminous signals the dots and dashes of the Morse alphabet. A small nut on the lever, G, permits of keeping F permanently depressed, so as to have a fixed light.

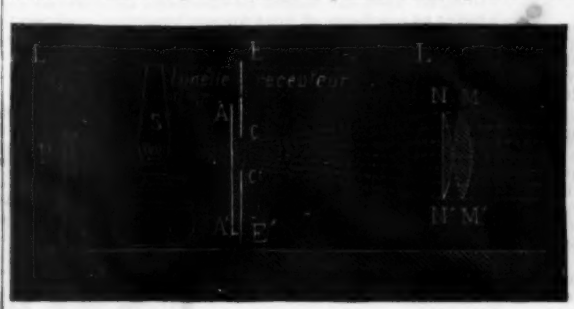


FIG. 12.

FIG. 13.

Receiving Telescope.—The telescope, LL, is fixed parallel with the axis of emission, and must be kept very accurately parallel therewith. To effect this, its ocular tube is embraced by two slides that are at right angles with each other, and that move, one of them vertically, and the other horizontally, through the intermedium of two micrometer screws. Parallelism is regulated as follows: Into a socket, DD', placed behind the optical apparatus (Fig. 14), is introduced a tube containing two converging lenses, A and B, and a piece of ground glass, *mm'*, provided with a hair-cross. The optical axis, *xy*, of the apparatus is thus exactly determined by two points. There is therefore nothing to be done but to aim at the same distant object with the receiving telescope, and, as soon as it is observed, to fix the telescope's position by means of the two slides above mentioned.

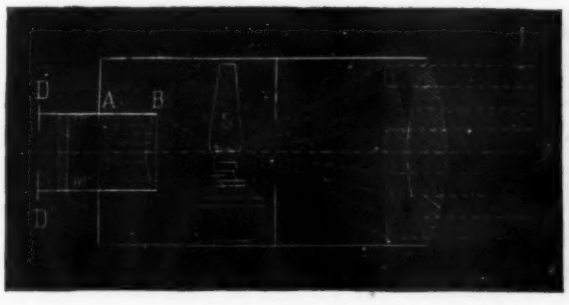


FIG. 14.

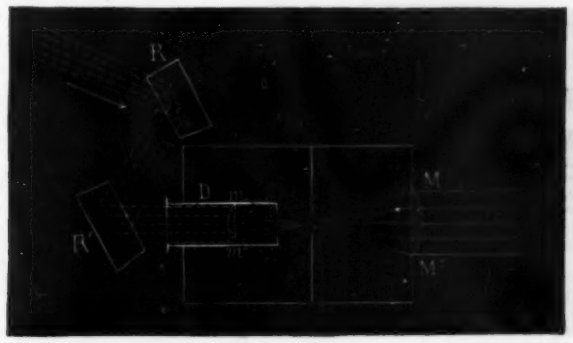
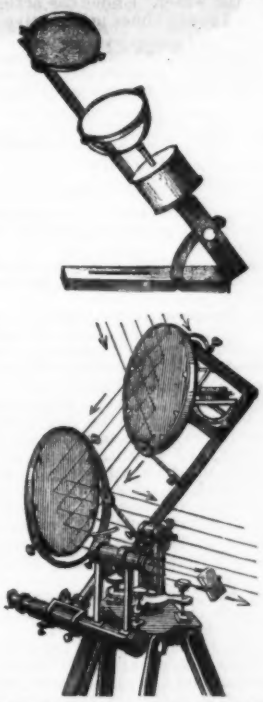


FIG. 15.



FIGS. 16 AND 17.—HELIOSTAT.

Regulation of the Luminous Source.—When a kerosene lamp is used, the same socket, DD, and ground glass, *mm'*, permit of regulating its flame. To effect this, the tube is shoved in more or less until the image of the flame occupies exactly the vertical diameter of the hair-cross. Then the tube is removed and the small concave mirror, P (Fig. 12), put in place. This latter gives a reversed image of the flame. It is now only necessary, in order to regulate the apparatus, to superpose this image of the flame with the flame itself—this being easily done by viewing the lamp through the emission objective, and slightly moving the small mirror.

The degree of excellence of the signaling depends upon the quality of the luminous source. It is well to cut the lamp wick slightly convex, with a pair of scissors. The flame will then have the aspect of a butterfly, and, when placed in the axis of the apparatus, will thus act in the whole depth of it.

Use of Solar Light.—Whenever it is possible, it is advisable to use solar light, which, as shown by the tables of ranges that we have given, permits of signaling to a greater distance than artificial light does.

Sun-light is concentrated and projected according to the optical axis of the apparatus in two ways, viz., by conjugate plane mirrors and by a heliostat. In the first case, the solar rays are received upon an inclined mirror, R, supported by the box of the apparatus, and are reflected from R to another mirror, R' (Fig. 15), which is carried by a tube, D, whose axis coincides with the optical axis of the apparatus. The fascicle of solar rays concentrated in the interior of D is rendered convergent by a lens, *mm'*, in the tube, D, and then directed to the objective. MM'. On its passage it meets the screen and manipulator that we have described. By reason of the continuous moving of the sun, the position of the small mirror, R', must be modified about every three minutes. This is easily done by turning the tube, D, and its mirror, R, at a slight angle by hand.

It is well to note that the use of the mirror, R, is not essential, as the solar rays may be received directly upon the other one, R'.

In order that the operator may not have to be continually shifting the position of the tube, D, a special apparatus with clockwork movement has been devised, called a heliostat.

This consists of two circular mirrors of the same diameter, and exactly centered upon the axis of a clockwork movement inclosed in a sort of drum (Figs. 16 and 17). Its axis, AA' (Fig. 18), is so arranged as to form with the horizontal plane an angle, *a*, equal to the latitude of the place of observation. As for the piece, AB, which serves as a base for the heliostat, this is set according to the meridian by means of a compass. The result is that the axis, *aa'*, is, through these two determinations, parallel with the axis of the earth. As the clockwork is so constructed and regulated that the heliostat effects one revolution every 24 hours, this apparatus possesses the same angular velocity as the sun, and always preserves the same position with respect to it. The incident solar ray is therefore constantly reflected from one mirror to the other of the heliostat, then to the rectangular plane mirror, R (Fig. 15), and finally in a direction parallel with the axis of the objective, so as to constitute a luminous fascicle.

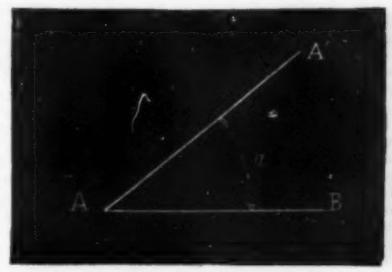


FIG. 18.

APPARATUS FOR OBSERVATORIES.

The optical apparatus for armor-clad observatories differ from those above described in that, being stationary in the place that conceals them, they must present as little visible surface as possible aside from

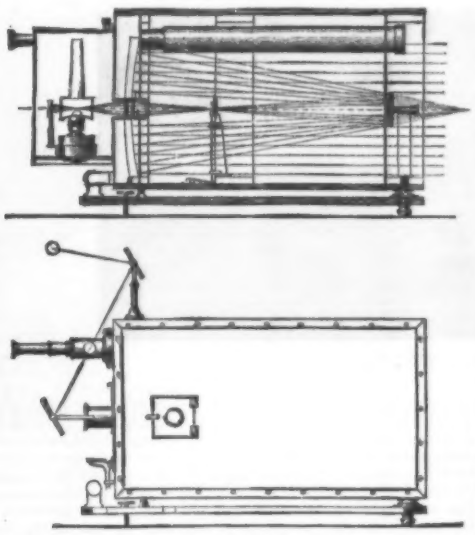
the fascicle projected by the objective. So, in these apparatus, the telescope, instead of being fixed upon the top of the box, is placed in the interior. The lamp is placed in a lantern apart that fastens on to the back of the apparatus. Finally, the small convex mirror for concentrating the luminous focus, and for regulation, is permanently fixed to its support. These apparatus form an integral part of our territorial defense, and, in case of war, would certainly render services of the highest order.

INFLUENCE OF FOGS, SMOKE, ETC.

Optical telegraphy is unfortunately apt to be interfered with by mist, fogs, and smoke. So the operation of the kerosene lamp, which generally serves as a source of light, requires particular care, since the smoke that it emits may suffice to form a light cloud that shall interrupt communications.

TRANSMISSION AND RECEPTION OF TELEGRAMS.

Two telegraphers are necessary for operating an optical apparatus. One of these reads the signals in a loud voice in measure as he receives them, while the other writes them down. Two distant optical telegraphic stations, during a campaign, begin in the first place by establishing in space a line of intercommunication. This is not always an easy thing to do, and for service of this kind in the face of the enemy it requires much coolness and courage. When the two stations have established a communication, each of them forms a fixed light, that is to say, the screen of the manipulator is kept permanently depressed by means of the nut above mentioned. The station that desires to communicate begins to form the signs of the Morse alphabet until its *vis-a-vis* has answered by hiding its light. The manipulation must be slow, and the intervals between the words be purposely exaggerated. When an error occurs, the receiving station interrupts its correspondent's communication by showing a light for about ten seconds. The correspondent, who, while manipulating, keeps his eye to the telescope, takes up the interrupted word at once when he sees the light. As soon as the message has been sent, the correspond-



FIGS. 19 AND 20.—TELESCOPIC APPARATUS FOR OBSERVATORIES.

ents show their light anew. As soon as one of them masks his light, he indicates that he has a message to send. The second answers by masking *his* light, and the work then begins. After each letter this latter sends a flash of light, in order to show that the same has been read. If one escapes him, he cuts off his correspondent by sending a luminous fascicle.

These rules, as well as others of less importance, permit of avoiding all confusion and delay.

HOW STATIONS ARE FOUND.

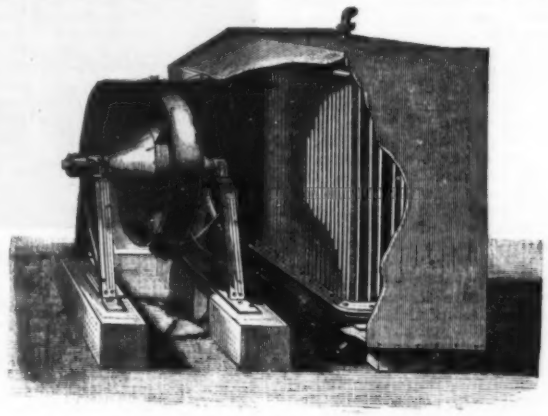
In time of war, telegraphers, as a consequence of the rapid and frequent changes of the corps to which they belong, are almost always ignorant of the exact position of their correspondent. So seeking for optical stations constitutes one of the most important parts of the service. With this object in view, each station must be provided with a map, compass, and protractor. When one of them knows the post with which he desires to put himself in relation, he begins by putting his map into position. To do this he places the compass at one side of the map, which he turns until the lines are parallel with those of the ground, and then he calculates upon the map, by means of the protractor, the angle formed by the line N–S of the meridian with that which runs toward the point sighted. By taking the declination into account, and by giving the apparatus the same deviation as the line of sight, he must infallibly succeed in finding his correspondent.

When two movable stations are looking for each other, the operation becomes more difficult. The two correspondents in this case divide the ground to be studied into sectors, and with the telescope observe the points upon which they suppose the station to be established. During this maneuver the apparatus is pivoting around its axis, and the luminous fascicle is projected over the ground passed over. As the field of the telescope is about double that of the apparatus, the two stations must surely succeed in finding each other by dividing the land into half-sectors.

THE AERO CONDENSER.

THE advantages connected with the operation of steam engines by condensation, both as regards saving in fuel and increase of power, are well known. But the usual processes of condensation are accompanied with equally well known inconveniences. Condensation through injection or surfaces requires a large quantity of water, say, for a good 100 h. p. engine, not less than 5,500 gallons per hour, or 55,000 gallons per day. At Paris, large quantities of water are easily obtained by boring artesian wells; but there are many countries in which recourse cannot be had to these, especially in granitic ones, where there are scarcely any wells that are capable of giving such a volume of water. It is therefore necessary to have recourse to cooling tanks, that take up much space and possess many other drawbacks.

These reasons explain why, even at Paris, where coal is dear and water relatively easy to find, there still exist many free escapement engines. Mr. Fouché thought that air might be effectively substituted for water as a vehicle of heat for condensation, and, after much experiment, brought out several years ago a surface condenser based upon the use of this agent.



FOUCHE'S AERO-CONDENSER.

The apparatus consists of a screw blower in which the screw or helix is like the helix of a ship. The air that this sets in motion impinges against a series of small tubes which the steam enters upon coming from the cylinder. An air pump of very small capacity extracts the condensed water and forces it into the feeding cistern. The vacuum obtained varies between 60 and 70 cm. of mercury. As the blower gives the air a pressure of but a few millimeters only, it expends but little work, and the use of the condenser effects an important saving in the running of the engine.

It is proved, then, that condensation by air can be practically effected and give good results. But the application presents another interesting character that it is well to notice. While water injection or surface condensers give rise to a considerable loss of heat, since the hot water is wasted, hot air, on the contrary, finds numerous uses—such as for heating workshops, drying, etc. There is no heat lost except that which is really converted into work. The aero-condenser, then, constitutes a heating and blowing apparatus of great power, and one that appears to be capable of being applied to the ventilation and heating of theaters and large establishments lighted by electricity, and consequently employing large engines.

The two obstacles to the construction of air condensers are the feeble calorific capacity of air and its being a poor conductor of heat. Mr. Fouché has obviated these as follows: By covering the surface of the tubes of the condenser with water, the air becomes saturated with steam at the same time that it becomes heated. The calorific capacity of air saturated with steam is, as well known, greater than that of an equal weight of water. At the same time, the transmission of the heat of the condenser is effected by virtue of the evaporation of the water. Under the action of the current of air, it is twenty times more active than in the dry air condenser.

This new apparatus, which the inventor calls the "moist air condenser," is more advantageous than the other, where the hot air cannot be utilized.—*Le Genie Civil.*

BALANCING THE ROTATING PARTS OF MACHINERY.

To the Editor of the Scientific American:

What are the prerequisites to the determination of what to do in treating a rotating body in its reduction to a running balance?

It must be set in rotation, and the rapidity of rotation must be sufficient to cause it to rotate upon its center of gravity.

If the above presentation be correct, it is necessary to secure to every rotating piece of machinery, for which it is desired to secure a running balance, all the freedom required for it to assume the character of a rotating body. This means that it shall be allowed to rotate upon its center of gravity, or, at least, as nearly so as is possible for a terrestrial body. The point of greatest prominence, then, indicating the point of greatest deficiency of weight, will show whence the excess of weight must be removed, or where it must be counterbalanced. Under no circumstances must the piece be allowed to assume the character of a revolving body. The distinction of a rotating body from a revolving body is vital to an understanding of the problem. By this consideration we are led to definitions.

A revolving body is one whose center of gravity moves in any path, circular or otherwise, around a controlling center of motion.

In contradistinction to a revolving body, a rotating body is one which rotates upon its center of gravity. Again, a rotating body is one whose components revolve in concentric paths about a point which is the center of gravity of the mass.

Being compelled, then, to accept as a revolving body one whose center of gravity moves in a path around a given point, regardless of the distance of the path from that point, and to accept only as a rotating body one which turns upon its center of gravity, it is easy to see that the line of demarkation may be often within such narrow limits as to lead to confusion.

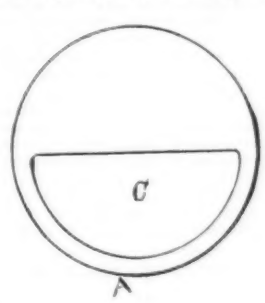
The assumption that a piece of machinery was intended to be a rotating body does not make it so. The distinction between the two bodies is a natural one, and we are not at liberty to ignore it. If the subject which we intend for a rotating body be not such, we must reduce it to the requisite condition by making its center of gravity coincide with its mechanical center. In securing a running balance, upon a pivot, as practiced by Pratt & Whitney, there must be a point, upon the line of the axis, at which the mechanical center and the center of gravity are coincident; and the position of that point must be scrupulously maintained throughout all the operations of balancing.

Many pieces of machinery intended for rotating bodies may have their centers of gravity so far from their mechanical centers that they will be unable to assert themselves as rotating bodies unless they have a far greater freedom from constraint than can be afforded by their means of support. Their effect upon the latter will then be that of a revolving body, with the accompanying phenomenon of centrifugal force. But there can be no excuse for theoretically confusing such a body with a rotating body. A recent writer, Mr. John Coffin, in an article entitled "The Balance of Rotary Parts of Machinery," in *American Machinist* of April 11, 1885, denounces as a failure a pamphlet issued by the Defiance Machine Works on the "Properties of the Rotating Parts of Machinery"—see SCIENTIFIC AMERICAN SUPPLEMENT, No. 368—and then, with a very happy carelessness of the whole matter involved, piles up a mass of mathematical formulæ regarding the conduct of *revolving bodies;* forgetting entirely the text with which he started. His hypothetical instances are ingeniously demonstrated, and exhibit admirable capability in illustrating examples of centrifugal force. Equally favorable mention might be made regarding a paper on navigation; but, in connection with the subject under consideration, all that can be asked is, What of it? The pamphlet was trimmed down to the requirements of trade, and, therefore, its presentations are partial and insufficient, even to the hazard of appearing faulty. But, as they have been carefully made, we are confident of their truthfulness.

Mr. Coffin writes eloquently, but he should not forget that correct apprehension is a qualification precedent to the solution of a problem. He who persists in building up demonstrations which do not apply to the case under consideration is destitute of the talent necessary to an intelligent discussion. We may be amused by his erratic flights, and even be willing to follow him among the stars, as we would step with Richter into the vestibule of infinitude, and trembling with awe behold the globes as they go whirling by. But the painfulness of being under any sort of misapprehension prompts us to protest against calling the adventure a fishing excursion. Mr. Coffin again writes: "The question does not seem to be a difficult one." To one who so inadvertently rambles away from the subject, it must seem *extremely* easy.

He who assumes the exalted role of mathematician should be careful, before piling up a huge fabric of demonstrations (?), that he has a fact to demonstrate. A daily newspaper writer has lately correctly hinted: "It is a well known fact that in physics, in which there is opportunity for exactness not possessed in many other sciences, there are few conclusions which are absolutely established, and which are not constantly subject to challenge, attack, and change."

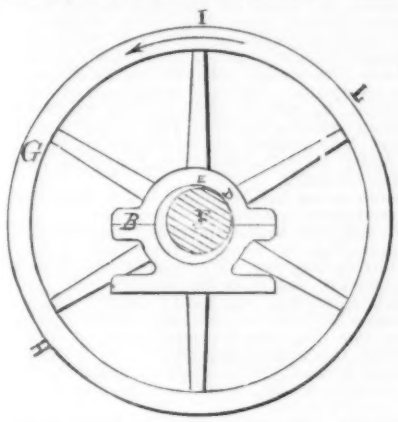
A disk of wood, one inch thick and eight inches in diameter, with a portion, C, cut away, was rolled up-



on a smooth floor at an initial velocity of about six hundred turns a minute. At the point, A, a coat of black paint was applied, so that a mark therefrom could be left on the floor. When the disk left the hand by which it was impelled, it seemed to roll smoothly on the floor for a distance of five or six feet, after which it was seen to rise and skip along the floor, touching it at intervals of two, four, and six feet, leaving a mark of black paint on the floor at every contact. It may, with truth, be said that there is nothing very surprising in this result, and that it is just what might have been expected. But, by the light which this simple experiment affords, is it extravagant to suppose that the driving wheels of locomotives, loaded as they often are with a superabundance of balance weights, may perform in a similar manner? To be sure, the great

weight of superstructure, and other constraints, may so restrict the driving wheel as to render its behavior different from that of the wooden disk, or even to cause its heavy side to impinge upon the rail the most violently. But, manifestly, the remedy for faulty running cannot reside in the augumentation of the heavy side, as is frequently attempted. Engineers who are interested in finding the causes of vibrations in railway bridges might consider this view with profit. See SCIENTIFIC AMERICAN SUPPLEMENT for June 16, 1883.

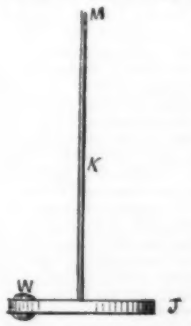
Let B represent a box in which turns a shaft, F, upon which a wheel, G, is fastened. Let L represent the light side and let H represent the heavy side. Let B be sufficiently larger than F to secure to L—when there



is a contact at D—the same moment of inertia as that possessed by H. If it be supposed that the contact at D is a sliding contact around the circle, B, unaccompanied by friction, L, the point of greatest deficiency of weight will be the point of greatest prominence. But the retarding effect of friction, producing a momentarily rolling contact, throws the contact forward to E; and thus the point of greatest prominence will be at I, or in advance of the point of greatest deficiency of weight. Viscosity of lubricants, variations of freedom allowed to B and F, and variations in velocity of G, will cause the point of greatest prominence to appear anywhere on the circumference of G. If, however, vibratory freedom be allowed to B, and it have no retarding influence by friction, G will rotate upon its center of gravity, and the point of greatest prominence will be at L. As in practice these latter conditions cannot be attained, so the point of greatest prominence and the point of greatest deficiency of weight cannot be made to coincide. But they can be brought so nearly to each other that in every instance, where the velocity is sufficient, all doubt disappears, and points at which weights should be applied, or excess of weight removed, are ascertained to a certainty.

In experiments with the cone pulley of a lathe, weighing about fifteen pounds, eight inches in diameter, running 6,000 turns a minute, out of balance one pwt., and marked while running, the mark occurred within 10 degrees of the point of greatest deficiency of weight, and in advance of the latter. Out of balance four pwts., the mark occurred on the heavy side. Out of balance twelve pwts., the mark occurred 120 degrees in advance—in the direction of rotation—of the point of greatest excess of weight. In all cases, excepting that in which it was out of balance one pwt., the point of greatest prominence varied greatly with the varying constraint by contracting and slacking the boxes, and by varying the speed. Under the first conditions, when out of balance one pwt., running 6,000, and the mark 10 degrees in advance of the point of greatest deficiency of weight, the boxes were as close as they could be without danger of heating. With the same tightness of boxes the speed was set at 3,000 turns a minute, and marks occurred 150 degrees in advance of the point of greatest deficiency of weight. The size of the journal at the larger end of the cone pulley was 1⅝ inches and at the smaller end 1 inch. The changing of lubricants produced varying results.

A disk, 4 inches in diameter, weighing two pounds, was run at 6,000 turns a minute, on a shaft supported by the centers of a heavy lathe. Every degree of tightness and looseness of centers, compatible with safety, was tried, together with weights of various sizes placed in a dove-tailed annular groove in the side of the disk. Variations in the sizes of the weights caused such contradictory variations in the positions of the marks that no reliable data could be educed. The speed being deemed insufficient to enable the disk to overcome the constraint imposed by the heavy lathe, the disk was placed on centers within light gimbals, held in the hand. It was then found that the marks occurred very nearly at the point of greatest deficiency of weight, notwithstanding the variations in weights and speeds, provided the speed were kept up to, and above, 3,000 turns a minute. The highest speed attained



was believed to be 8,000, at which the marks occurred nearest to the point of greatest deficiency of weight.

On some of the foregoing features light may be thrown by simple experiments with a disk, J, rotating in a horizontal plane and suspended by a flexible axis, K, secured against vibration at its upper end only. Let W represent an excess of weight, by which the disk is thrown out of balance. W, predominating over the other portions of the mass, will—by its tendency to move in a right line upon the initial rotary impulse imparted through the means of suspension—draw the flexible axis in the direction in which W tends. Thus far, W possesses the centrifugal properties of a revolving particle, and influences the mass accordingly. But as the rotary impulse at M continues, the mass becomes established as a rotating body, and W loses its identity as a revolving particle, drawing nearer to the position formerly occupied by the flexible axis.

A flexible axis can be no more than a consequent of the phenomena of rotation and revolution. If it can be conceived that an axis of infinite flexibility support a rotating body, such axis can in no wise be considered a factor in the phenomenon of rotation. An axis becomes a factor in proportion to its inflexibility, or more properly, in proportion to its rigidity, for no axis can be entirely free from flexibility. Also, in proportion to its rigidity does the body which turns upon it become more decidedly a revolving body, and become more remote from a rotating body. Mr. J. C. Hoadley has illustrated in some measure the conduct of rotating bodies upon flexible axes, and also the inverse, by instancing the behavior of an emery wheel, which may shake all its surroundings at a low rate of speed and be quiet at a higher velocity. The writer was once called upon to examine a shaft which was behaving badly, running about 600 turns a minute, and carrying a balanced pulley forty-eight inches in diameter by eight inches face. It was found that the shaft, which was light, $2\frac{7}{16}$ inches, had become bent by careless handling when put in place. The bearings were ten feet apart, and the pulley had been very imprudently placed about midway between bearings. At maximum speed the pulley, predominating in influence, kept the shaft comparatively steady, producing only a slight disturbance at the boxes. But when the speed was decreased to the point at which the bent shaft could assert itself, vibrations ensued which threatened destruction to pulley, shaft, and all their adjuncts. In this case the earth's attraction entered into the problem by aggravating the bend of the shaft in one position and mitigating it in the other; while the pulley, by exerting a momentarily correcting influence, and then relaxing it by reason of slight variations in speed, only increased the disturbance; becoming like a body oscillating between two alternating, and repelling forces.

An emery wheel mandrel will often have its journals worn out of concentricity by carrying an unbalanced wheel, and then, when a balanced wheel is substituted, a violent disturbance is noticed until the wheel attains a governing velocity. The journals, in such a case, will, of course, have lost their proper bearing, and will ream the boxes somewhat, but may run much more smoothly at a high rate of speed than at a low rate.

With regard to the balancing of the reciprocating parts of steam engines, as represented in the SCIENTIFIC AMERICAN SUPPLEMENT of March 7, 1885, it has been urged that steam engines never run at so high a speed as to insure, in their rotating parts, a rotation upon their centers of gravity. As a provisionary answer it may be said that, then, there is no certainty as to what portions of such rotating parts throw so as to be points of greatest prominence. It has been shown that varying degrees of constraint, speed, weight, etc., cause such wide variations in positions of points of greatest prominence that the latter cannot be taken as indications of the positions of points of greatest deficiency of weight, unless the velocity of rotation be sufficient to dominate their adjuncts. On page 20 of the pamphlet to which Mr. Coffin refers, it is stated that the treatise regards only such bodies as are under that condition. It has been urged that its application to the subject treated on page 29 is invalid and unfair—see SCIENTIFIC AMERICAN SUPPLEMENT, No. 368. We are aware that its application cannot be otherwise than theoretically made; but we deny that it is invalid and unfair; for nothing less can conduce to a thoroughly comprehension of the principles involved. Nearly all that has been done in attempts at balancing the reciprocating parts of steam engines, by counterbalances in cranks and wheels, has led to a labyrinth of absurdities. The minds of such as have been in the quest have overlooked the effects of counterbalances in directions perpendicular to the line of travel of reciprocating parts. Confusion in this matter seems to have arisen from failure to distinguish rotating bodies from revolving bodies.

CHARLES SEYMOUR,
Supt. of Defiance Machine Works, Defiance, Ohio.

JACOMY'S HIGH-SPEED MOTOR.

THE daily increasing applications of electric machines to the production of light have given a new impetus to the construction of high-speed motors. There are already several styles of these known to our readers, but the one that we shall now speak of in no respect resembles those hitherto described. This apparatus is the invention of an artillery officer, Mr. Jacomy. A 10 H. P. model set up at the Tarbes Arsenal is now actuating a Gramme machine that supplies 3 arc lamps of 500 Carcel burners power.

Fig. 1 gives the general aspect of the motor, which consists of two parts, A and B, symmetrically placed, and each forming a distinct engine. It might be supposed from its appearance that this was a rotary motor, but such is not the case. The steam acts in each engine upon pistons, to which it communicates a rectilinear motion, and which directly actuate two wimble-shaped cranks set at an angle of 180° with each other upon the same shaft. In this way there is no dead center and no vibration. As the two engines, A and B, are counterparts of one another, we shall describe but one of them. The internal mechanism of this is shown in Fig. 2. In a cast iron disk, whose thickness varies according to the power of the motor, there is a rectilinear chamber, *a b c d*, which may be hermetically closed by two plates applied to the two surfaces of the disk. One of these, which is not visible in the figure, serves as a partition, and is common to the two engines, while the other, P, is fixed to the external part by bolts. In Fig. 2 this is shown apart. In the interior of the chamber, *a b c d*, there moves horizontally a piston, C, that has the form of a frame, and consequently presents in the center a second rectangular chamber. In this latter there moves vertically a second piston, D.

In combining the two motions (the one horizontal and the other vertical) that these two pistons are capable of effecting, a complete circumference is described in the center of the smaller. As the crank pin is fixed to this point by means of bearings, the shaft of the motor is thus set in motion. This shaft traverses the center of the plates, and is supported by pieces, H (Fig. 1), that are affixed to the plates. As in all its positions it undergoes exactly equal and diametrically opposite stresses, and as, moreover, its bearing points are near one another, it may be considered as actuated

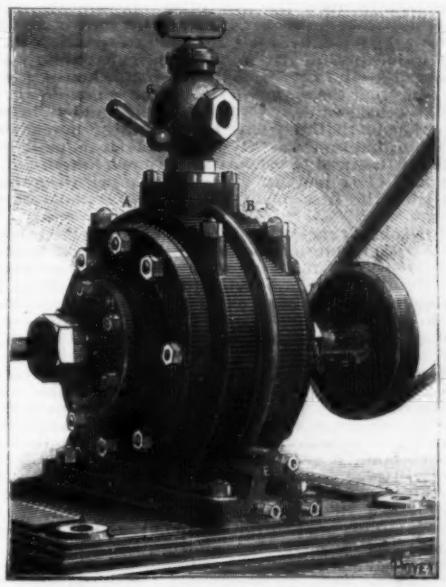


FIG. 1.—THE JACOMY MOTOR.

by a nearly perfect revolving stroke that imposes upon it no flexion or torsion stresses. In the circumference of the disk, that is to say, in the entire part that surrounds the rectangular chamber, *a b c d*, and serves as a jacket thereto, there are channels for the conveyance of steam.

At E, in Figs. 1 and 2, may be seen the extremity of one of these, provided with a flange to which is attached the steam pipe. Starting from thence, the stream flows around the jacket and reaches the grease cock at G, where it becomes charged with the lubricant necessary for all the rubbing parts, and then reaches the orifices, 1, whence it passes into the plate, P, which contains conduits for its circulation. The internal surface represented in Fig. 2 shows the orifices, 1, 2, 3, 4, 5, and 6, of these conduits, all of which end in the central aperture, M. The orifices, 1, seen at the top are applied against those of the jacket carrying the same number. The steam on making its exit from the grease cock is led, then, directly to the center, M, of the plate. Here there is a distributer, T (shown apart in Fig. 2), whose role is analogous to that of the slide-valve in ordinary engines. This is fixed upon the shaft, and consequently revolves therewith. It is provided with cavities that present themselves in succession in front of the orifices of all the cavities, so as to put them in connection by twos. One of these orifices may be seen in

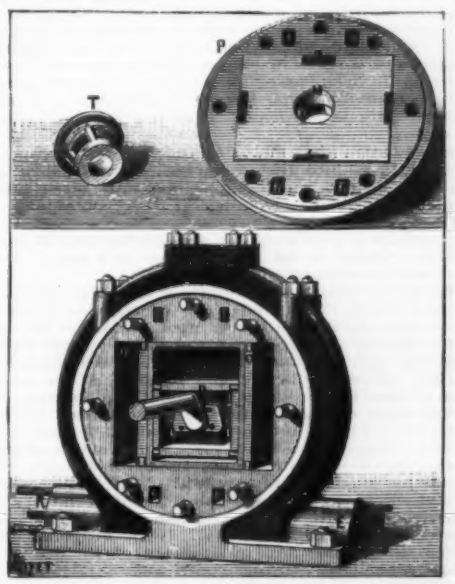


FIG. 2.—DETAILS OF THE MECHANISM.

the central aperture of the plate, P. The steam coming in through the conduits, 1, can in this way pass through 2 and 3 in order to act upon one of the sides of the pistons, while the other side of the latter will be put in communication with the conduits, 4 and 5, which, at the some moment, will communicate with the eduction ports, 6, the extremity of which is seen at 6. The distributer is conical, and, although fixed to the shaft, is capable of moving longitudinally under the action of a spiral spring, which tends to press it into the aperture, M, where it is placed, in order to obviate the wear that occurs during the running. The expansion may be modified by varying the position of the ad-

mission orifices with respect to that of the eduction ones. This result is obtained by means of levers that are maneuvered from the outside, either by hand, or automatically by a regulator. This arrangement is not shown in the figure because it was not applied to the model used by the draughtsman.

A small model of a nominal 1 H. P. in the possession of Messrs. Duchin and Tricoche, grantees of the patent, weighs but 33 pounds and has a velocity of 1,500 revolutions per minute at a pressure of 13 pounds. These builders have just got up another one of the same power, but with a modification which permits of operating it as a compound engine. The distributer is so arranged that the steam, instead of escaping into the atmosphere, after acting upon the pistons, is utilized a second time. It first enters the frame, C, whence, after acting upon the axis of the faces of the small piston, it passes into one of the sides of the rectangular chamber, *a b c d*, in order to act by expansion upon the frame piston, and it is not until after this that it escapes into the air. Under such circumstances, it will be seen that the saving in steam, and consequently in fuel, is considerable. According to the builders, in two experiments that they have made with this new model, the consumption was 44 pounds of steam per horse and per hour, at a velocity of 1,800 revolutions and a pressure of 11 pounds. As compared with the trials made of the first model, the saving was about 30 per cent.

The velocity can, without fear of breakage, be carried up to 3,000 revolutions per minute. The lateral friction is entirely due to the pressure of straight bars which are fixed along the pistons, and which are thrust by springs against the sides of the chambers in such a way as to secure a complete cut-off. Such pressure is very feeble, and the wear over the entire surface is very slow and regular.

Through its arrangement, then, this motor is capable of running at a great speed, while at the same time preserving to the parts susceptible to friction velocities that do not exceed 60 feet per second at a maximum. This figure is somewhat high if we consider that in other engines it is at a minimum of 47 feet, and reaches a hundred or more in locomotives. The space required for this motor is very limited, and foundations are unnecessary. All the reactions resulting from the alternating motion are neutralized upon the shaft, and the engine may without inconvenience be fixed upon a bracket against a wall for actuating shafting without any intermedium. By connecting it with the boiler by a flexible tube it may be directly coupled with a tool movable in several directions. These qualities will cause it to be employed with advantage for actuating electrical machines, centrifugal pumps, ventilators, circular saws, and other high speed apparatus. Mounted upon a boat, it will occupy but small space, and may be placed very near the screw, and, if need be, may be placed upon the rudder in the case of small boats. In addition to steam, it is capable of using air, compressed gas, and particularly carbonic acid expanding after liquefaction. Finally, it is reversible, that is to say, it is capable of operating as a suction or force pump for liquids and gases. This engine of Mr. Jacomy's, then, is adapted to a host of applications, and will be employed with advantage in a large number of cases by both private individuals and manufacturers.

PHYSIOLOGICAL CURIOSITIES.

IF, while on the cars, we put our head out of the window and get a microscopic cinder in our eye, we at once experience extreme pain, the irritation is violent, the cornea becomes red through the congestion of the capillary vessels, the mucous membrane of the interior of the eyelid is inflamed, the lachrymal secretion is overstimulated, and the eye weeps abundantly. Then the head becomes heavy and painful, and this state may last for three, four, five, or more hours, until the cinder has been expelled by the tears or other means.

The same thing occurs, and the same annoyance is experienced, when the globe is touched, even but slightly, with the finger, a branch of a tree, or any foreign body whatever, or when a particle of dust, a fly, or an eyelash gets beneath the eyelid; so it is with a legitimate surprise that we see certain persons place between the eyelid and globe, without apparent pain, certain relatively large foreign bodies, such as silver cylinders (Fig. 1) or small lens-shaped pebbles, called "swallow stones" (Fig. 2).

Experiments with Silver Cylinders.—Those who introduce these into their eyes are generally such as make a business of doing so, and are often poor wretches who wander from saloon to saloon repeating their experiments for a few cents. At other times the experiment is performed by prestidigitators. Robert Houdin relates in his memoirs that it is one of the first that he knew how to perform.

The mountebank who exhibits in the public squares or boulevards during fete days operates as follows: In his hand he holds a saucer upon which lie two or three little silver cylinders of the size of a goose quill, that is to say, about an eighth of an inch in diameter by half an inch in length, and rounded at the ends. One of these he introduces between the globe and lid of the right eye, and causes it to disappear. It first causes the eyelid to project, then descends farther, and finally becomes absolutely invisible. Then, opening his mouth, the trickster shows the cylinder upon the end of his tongue, and removes it. Next, he places the cylinder in his left eye, and takes it out of his right, and that, too, without using his hand, and by the simple contraction of the eyelid. Next, he places the object in his nose and takes it out of his left eye. Finally, he places it in his mouth and takes it out of the nasal fossæ.

In all this there is naturally a trick that tends to make it believed that it is possible to pass an object from the eye to the mouth, from one eye to the other, and from the mouth to the nose, and *vice versa*. Now, in reality, the thing is not possible.

It is perfectly true that the nose and mouth are in communication, for the nasal fossæ end, in fact, at the pharynx, and the smoker who expels smoke through his nose utilizes this communication. So in fact does the person who is using a blow-pipe; but in the opposite direction. Sometimes, also, when we swallow "crossways," a violent effort expels a piece of food through the nasal fossæ. A communication likewise exists between the eye and the nasal fossæ, and we can even see the opening of it in the inner corner of the eyelid; it is the tear-duct. This aperture serves, so to speak, to carry off the lachrymal secretion and lead it into the nasal fossæ. If the secretion of tears becomes very abundant, as in pain or grief, the duct no longer suffices, and the tears overflow and run down the cheeks. But this duct is much too small to permit the passage of an object of the size of the cylinders of which we have spoken. And so, too, communication between the nasal fossæ and the mouth, which is easy when it concerns a puff of air or smoke, is extremely difficult and painful when it is a question of a hard body, however small it be. In reality, the experimenter introduces one of these small cylinders between the globe and eyelid, and causes it to disappear; this is all the physiological curiosity. When he makes believe take it from his mouth, it is evidently another one that he had previously hidden therein. And so when he places the cylinder in his left eye and takes it

FIG. 1. FIG. 2.

SILVER CYLINDERS. SWALLOW STONES.

out of his right, he removes merely the first that he had introduced into this eye; and so on for the other experiments.

From another point of view, we may ask how this insensibility of the eye may be obtained. It must be remarked in the first place that the eye, which is so sensitive to the contact of rough objects, however small they be, is much less so to perfectly smooth and polished ones, such as the silver cylinders under consideration. Moreover, it is a question of getting accustomed to the thing. In the operations of the oculist the first contact of the instrument with the globe of the eye is especially painful, and provokes an abundant secretion of tears; then the eye gradually gets accustomed to it, and in a few instants the contact of the smooth instrument with the cornea is no longer painful, although the transparent portion of the globe always remains very impressionable. The first introduction of the silver cylinder into the eye must be very painful; the second is a little less so; and a few days of experimentation permit of obtaining a complete insensibility of the eye to the operation. Those prestidigitators who are capable of introducing a 50 (or more easily a 20) centime piece under the eyelid have likewise not acquired the talent until after some days of an apprenticeship that is painful at the beginning (Fig. 3).

Swallow Stones.—Physicians of antiquity and the middle ages attributed curative properties, in a large number of ailments, to preparations made from the swallow. For example, the ashes of young swallows cured quinsy. The eating of a swallow cured the quartan fever. A potion made of the swallow's heart strengthened a weak memory. In the bodies of young swallows certain stones were found that cured various maladies. Those found in the nest were preventives of colds. Pliny, Galen, and Celsus praised the virtues of swallow stones, and the most celebrated physicians of the middle ages copied their predecessors. Swallows were reputed to have a highly developed sight. They

FIG. 3.—A 50 CENTIME PIECE INTRODUCED INTO THE EYE.

had the gift of never losing this faculty, and, if their eyes were put out, others grew in their place. The result was, according to the manner of reasoning that was the base of the ancient pharmacopœia, that all preparations having the swallow as a basis were excellent for man's eyesight and for diseases of the eyes.

Now this belief has been perpetuated through tradition up to the present time; and, in our own day, it is related in the smaller villages that the swallow is born blind, its eyes being covered with a film, and that the mother goes afar to look for a little stone endowed with peculiar properties, which she applies to the film and causes it to at once disappear. It is this little pebble, which cures maladies of the eyes and blindness, that old women carefully search for when a swallow's nest has fallen by accident or been knocked down (Fig. 2).

This is legendary, but it is certain that there are small stones carefully preserved in certain families that possess very curious properties in connection with the eyes. We have been witness to a few facts relative to one of these. It was a pebble in the form of a lens and about the size of half a chick-pea. It seemed to be of quite fine silicious sand, and was polished, and had rounded edges, but nevertheless was irregular on its convex side. This little stone was considered by the family as extremely valuable. It was called a "swallow stone," and had been transmitted from generation to generation, so that its origin was unknown. It was used as follows. If by chance a particle of dust, an eyelash, or a straw got into the eye and occasioned the usual trouble—pain, tears, or headache—recourse was at once had to the stone, which, being placed in the corner of the eye, affixed itself to the globe as soon as it came into contact with the tears, and disappeared under the eyelid. The pain occasioned by the foreign body ceased at once, to the joy and astonishment of the person who for the first time tried this singular remedy. The swallow stone, despite its size and the irregularity of its surface, occasioned neither inconvenience nor pain.

The few stones that we have heard spoken of have been analogous in form and size to the one just mentioned, and their action upon the eye the same.

It seems that the action of these little stones can be explained in this way: The stone, being hygrometric, is attracted to the globe by contact with the tears, through the effect of capillarity simply. Thus wetted, it becomes perfectly smooth, and irritates neither the cornea nor the mucous membrane of the eyelid. Moreover, this latter being lifted, the foreign body is no longer pressed, and no longer irritates the surfaces with which it was in contact; and the annoyance therefore ceases at once.

As we have said, these stones are extremely rare; but it is probable, however, that a diligent experimenter who should consent to try a certain number of pebbles taken from a handful of river-sand might discover some that had the wonderful properties of the "swallow stone."

RECOVERY OF GOOD SIGHT AFTER TWENTY YEARS' BLINDNESS.

DR. GEORGE E. WALKER thus writes in the *Lancet*, June 6:

Accustomed as I have been, during some dozen years' practice of the operation, to the great benefits resulting from the severance of adhesions of the iris to the cornea, I confess that the case which I now relate has astonished me not a little.

L. *N*——, a girl aged nineteen years and three months, was admitted to the School for the Indigent Blind on April 22, 1884. Her right eye showed all the cornea, except a narrow rim round the margin, as one dense leucoma to which the iris was universally adherent. Of course, this was hopeless. The left, in the central lower part, showed a dense leucoma, which shaded off rather abruptly into a fainter one just above, the whole leucoma having a diameter about half that of the cornea. The iris was adherent to the central part of the leucoma, except at the inner side, where a little of the pupillary edge had escaped, so that a very small pin-hole was left; but as it was behind the leucoma and could only be seen sideways, it was not available for vision, and the girl said that she could see no better with the left than with the right eye, nor could she count fingers with either, but had only perception of light.

Thinking that I might give the left eye enough sight to enable her to move about without knocking against chairs and tables, I suggested to her and her father the propriety of treatment; but when they found out an operation was required, I received a prompt negative. At last the father consented that the girl should please herself, but it was not until November that she asked me to operate on her. On the 22d I attacked the upper part of the adhesion in the way described in the *Lancet* of January 31, p. 197, gaining a considerable increase of pupil. She suffered somewhat from the chloroform, and consented very reluctantly to the second operation, by which, on December 10, the severance of the upper limb was completed. On January 6, I divided the lower limb at one sweep, although it was very broad, and on the 13th I cut the little bit remaining on the outer side. She was so averse to this last operation that I had to pretend an anger which I did not feel, and almost compel her to submit. One would have expected that the great benefit which accrued most markedly after each operation would have made her eager to submit, but the contrary was the case. Her first sensation after admission of light into her eye was one of profound horror. She says now that when she first became conscious of sight, and therefore to some degree of space, her feeling was like that of one who looks over a precipice and fears that he will be impelled to throw himself down, and she, at the time, bitterly repented her consent to be taken out of the darkness which all her life thus far had enshrouded her. By this time, however, the leucoma had cleared up, especially in the upper part, and we found that she had a good-sized pupil, elongated from side to side, the upper, lower, and outer edge ragged from the cuts, while the inner presented the normal curve. I had hitherto thought it most probable that the lens had been destroyed, but now I found it existent and transparent, and on testing the eye (January 28) discovered that the long tension of the imprisoned iris had produced a myopia, requiring a 15 D. glass for its correction. The wearing of this speedily caused a change in her state of mind, and she soon ceased to regret her loss of blindness. Under the affectionate tuition of a fellow patient she learned her letters in a day, and to read in a week. Of course this was all the easier from her ability to read with her fingers on Moon's types. Like as occurred in the little boy whose case is described in the *Lancet* of January 31, 1885, a filament of uveal exudation joins the lower edge of the pupil to the cornea, and I shall divide this if I have reason to believe that it keeps up, in any material degree, the over-nutrition of the leucoma. This, however, now deprived of the large blood-supply given to it by the almost universal adherence of the iris, has cleared up greatly, the upper part being almost transparent, and her vision is now (March 2) $\frac{2}{60}$, and she reads pretty

easily Jaeger 10, and with some little difficulty Jaeger 8—that is, print about the size of "leading article" type.

The main element of the surprise which I have experienced over this case is the retention of visual acuity by the retina under the twenty years' deprivation of light. I see so many examples to the contrary in the persons who present themselves at the Blind School—as, for example, in cases of neglected cataract, as well as in the more familiar instances of squint, which produces the amblyopia (ex inopsia of the old writers), that I was not prepared to find that in this girl the retina had preserved its sensitiveness so well; for all the want of acuteness now present may safely be debited to the opalescence of the cornea, which still remains. As this, however, is plainly decreasing, I trust that the eye may further improve. Another interesting fact is that the muscular tissue of the iris shows itself to be quite lively, as it responds promptly both to myotics and mydriatics.

I think now that I have said enough to show that this class of case—a more numerous class, probably, than that of cataract—is susceptible, even in the more formidable instances, of beneficial treatment, and that on the whole we may expect results at least as satisfactory as in other grave diseases of the eye.

THE TREATMENT OF FRECKLES, MOLES, ETC.

AT this time of the year there are few questions which are more frequently addressed to the "family chemist," and fewer still to which he ordinarily gives so unsatisfactory a reply, as, "What shall I do to cure my freckles?"

Knowing as we do how greatly the popularity—*i. e.*, the business prosperity—of the majority of our friends depends upon the votes and interest of their lady customers, we have been at some pains to lay before them such an amount of practical information upon the above subject as will enable them to retain the good will and material gratitude of their fair interrogators, on the one hand, and to put a little extra profit in their own pockets, on the other.

We do not propose to convert these pages into an elaborate treatise upon the skin; but for the benefit of those who are only just commencing business it will, perhaps, be as well to make a few observations which our more experienced friends may consider of the "leather and prunella" order. In the first place, it will be generally admitted that upon the subject of our present notes there is no published information of a practical and reliable character, and that medical writers and practitioners either shun the question altogether or approach it in a perfunctory manner, and leave it very much where they found it. For our present purpose the cutaneous discoloration commonly designated by the term "freckles" may be considered under two heads—the so-called "summer" or temporary variety (*ephelis*) and the permanent kind (*lentigo*). Both are commonly stated to be simply morbid alterations of the skin-pigment, and to be situated solely in the *rete mucosum*, but this is not absolutely true, inasmuch as *ephelis*, properly so called, is generally due to a darkening of the under surface of the epidermis either in small ovoid patches ("summer freckles") or extended over a large surface ("tan" or "sunburn"), while with *lentigo* the brownish discolorations are at a greater depth, and remain *in situ* after the covering epidermis has been completely removed. Strong sunshine, or any powerfully actinic light, and radiant heat from any source are apt to produce the first named, and to enhance the latter form of the skin's chromatogenous function, the manifestations of which vary greatly according to individual idiosyncrasies.

Similarly, the treatment which answers best for some persons is not so efficacious in other cases, but the old old adage that "prevention is better than cure" applies here with considerable force, and as regards the *rationale* of remedial applications, it may be said in general terms that the application, in the right place, of active reducing, or deoxidizing, agents is as a rule successful in removing *ephelis* altogether, and in greatly toning down the shade of *lentigo*. Commencing with the mildest form, we will give a good formula for a

SUNBURN LOTION.

℞ Acid citric	ʒ i.
Ferri sulphas *pur*	gr. xviii.
Camphora	q. s.
Aq. flor. sambuc	ʒ iii.

The sulphate of iron must be in clear green crystals, unless the "granulated" form, which is preferable, be available, and in either case the salt should be fresh and free from oxidized portions, or "rustiness;" it should be dissolved in half the elder flower water (all of which is better, if not quite recently distilled, for being quickly raised to the boiling point and cooled out of contact of air before use), the citric acid being also in solution in the other half, and the two fluids mixed, filtered if necessary, and bottled immediately, a lump of camphor about the size of a small peppercorn to be added to the contents of each bottle.

HYDROKINONE WASH FOR THE SKIN.

℞ Hydrokinone	gr. xlviii.
Acid phosphoric *glac*	gr. xxx.
Glycerine	ʒ ii.
Aqua dest	ʒ vi.
Misce.	

These two lotions are stated to give excellent results, especially the latter. They are to be applied to the skin of the face, etc., in the usual way, at least twice in the course of twenty-four hours, after it has been washed and dried carefully. If the skin be of the nature known as "greasy," a preliminary wash with tepid water containing a few drops sal volatile or liq. ammon. fort. is advisable.

ALBADERMINE.

Under this empirical title, a process of removing "tan" and the milder variety of "freckles," a foreign surgeon has devised the following:

SOLUTION A.

℞ Potass. iodid	ʒ ii.
Iodine *pur*	gr. vi.
Glycerine	ʒ iii.
Infus. rosæ	ʒ iv.

Dissolve the iodide of potassium in a small quantity of the infusion and a drachm of the glycerine; with this fluid moisten the iodine in a glass mortar and rub it down, gradually adding more liquid until complete solution has been obtained; then stir in the remainder of the ingredients, and bottle the mixture.

SOLUTION B.

℞ Sodæ hyposulph. (*thiosulphate*)	ʒ iss.
Aquæ rosæ *exot.*	℥ j.
Dissolve and filter.	

With a small camel's hair pencil or piece of fine sponge apply a little of "Albadermine A" to the tanned or freckled surface, until a slight but tolerably uniform brownish-yellow skin has been produced. At the expiration of fifteen or twenty minutes moisten a piece of cambric, lint, or soft rag with "B," and lay it upon the affected part, removing, squeezing away the liquid, soaking it afresh, and again applying until the iodine stain has disappeared. Repeat the entire process thrice daily, but diminish the frequency of the application if tenderness be produced. In the course of from three or four days to as many weeks the freckles will either have disappeared entirely or their intensity will be very greatly diminished. "Summer freckles" yield very speedily to this treatment.

ANTI-FRECKLE LOTION.

℞ Hydrarg. bichlor	gr. xii.
Acid hydrochlor. *pur*	ʒ iii.
Fruct. amygd. amar	ʒ iss.
Glycerini (*Price's*)	ʒ i.
Tinct. benzoin	ʒ ii.
Aqua flor. aurant	q.s.

Dissolve the corrosive sublimate in three ounces of the orange-flower water, add the hydrochloric acid, and set aside. Blanch the bitter almonds, and bruise them in a Wedgwood mortar, adding thereto the glycerine and using the pestle vigorously; a smooth paste is thus obtained. Then add gradually about nine ounces of the orange-flower water, stirring constantly, continuing this operation until a fine, creamy emulsion is the result. Subject this to violent agitation—preferably with the aid of a mechanical egg whisk—and allow the tincture of benzoin to fall into it the while drop by drop. Then add the mercurial solution, filter, and make up the whole to the measure of one Imperial pint with more orange-flower water.

This preparation is recommended to us by an eminent dermatologist as being invariably efficacious in the treatment of *ephelis*, and always greatly ameliorating *lentigo*, even if it does not entirely decolorize the patches in the latter case. A general whitening of the skin is produced by this lotion without any irritation. It is as well, however, not to apply it to any abraded surfaces. It has been found far superior in practice to a preparation—which it somewhat resembles—sold at a high price in Paris under the name of *Lait Antiphelique.*

BISMUTH OINTMENT FOR FRECKLES.

℞ Bismuthi subnit	ʒ iii.
Ung. simp	℥ ii.
Fiat ung.	

Apply to face, etc., at night, and remove in the morning with a little cold cream previous to washing. This is from a private American source.

COPPER OLEATE FOR FRECKLES, ETC.

This is a much more effective and reliable ointment for the purpose than the preceding, which is really only suited for the milder form of sunburn, while the oleate of copper will remove the more persistent and obstinate *lentigo*. It is thus prepared:

℞ Cupri oleas. *ver*	℥ i.
Petrogell. alb. (*Burgoyne's*)	℥ iii.
Incorporate thoroughly without heat.	

This is to be applied in the same manner as the preceding, washing the surface of the skin, however (after the cold cream), about every third morning, with a little weak ammonia water, in order to prevent any inadvertent accumulation of copper.

Several of the preceding are well adapted for the treatment of very dark colored and deep seated examples of *lentigo*, of which, however, some seem capable of resisting all treatment of this kind. The only method of reaching these is by the complete removal of the epidermis of the part and of the upper portion of the *cutis* also. A Turkish bath is often useful as a preliminary for an effort of this kind, which, of course, needs the application of some disorganizing substance. Permanganate of potassium answers in this direction, but we find that a moderately strong solution of Mr. H. B. Condy's new disinfectant—permanganate of aluminum—is undoubtedly the best of the two for this purpose. It should be applied several times until the skin has acquired a uniform brown tint. At from one to twelve hours after this is noticed, it should be removed by a warm and dilute solution (about 8 or 10 per cent.) of hydrochloric acid, to which a little glycerine may be added to prevent too rapid drying. Still better however, is nitric acid, which, if "painted" upon a colored spot of this kind, first renders it more distinctly yellow, then orange-brown. In a day or two this becomes a deeper brown, and more or less disorganized, cracking, either round the edge, or right across the center, so that it can be readily peeled away. Freckles removed in this manner seldom crop up again, in that particular place at all events. In this connection it is a somewhat curious fact that whereas *dilute* nitric acid often caused soreness and irritation when applied in this manner, a stronger acid does nothing of the kind, but quietly and quickly "deadens" that portion of the outer covering it has been applied to, so that in a day or two it can be removed quite painlessly. What is known as "French nitric acid," of from 1·330 to 1·350 specific gravity, is very appropriate for this purpose.

COCAINE AND NITRIC ACID FOR MOLES, ETC.

The removal of either deep-seated freckles or moles is, as before hinted, not always an easy task, but nitric acid is, perhaps, about as good an agent for the purpose as any other. The mole should be surrounded by a little "cell," or ring, of wax, so that the acid can be applied direct without fear of disorganizing the adjacent skin. As, however, nitric acid, by itself, sometimes occasions a good deal of smarting, etc., when applied, it is better to avoid this by mixing cocaine with it. The mixture given below answers the purpose very well indeed.

℞ Acid nit. (s. g. 1·340)	ʒ i.
Cocaine (*ver*)	gr. vi.

This should be kept ready for use in a small bottle with a good-fitting stopper. The end of a glass rod dipped in, and then cautiously applied to the surface of the mole or freckle, the process being repeated once or twice a day, and the unsightly spot has its vitality destroyed without pain, being then easily and effectually removed.—*B. & C. Druggist.*

INSANITARY HOUSES—A CAUTION.

IN the face of a scourge which is but a few hundred miles from our shores, a thorough inspection of houses and apartments at seaside and other places ought to be considered an indispensable step. There are flaws in local acts, or rather the administration of them, which may render our boasted sanitary condition all but a snare to be discovered when it is too late. Sanitary boards may entertain the delusive idea that their arrangements are above suspicion, and regard with defiance a foe which is decimating one of the most fertile of European countries, and all the while, it may be, there remains a lurking danger which our sanitary measures have to some extent created. At the moment we write, an outbreak of typhoid of a severe form at the West London District School, situated between Staines and Ashford, is a warning of the danger we are pointing out. No less than 239 patients, which is more than a third of the whole school, are said to be in the hospital wards of the school smitten down by the epidemic. The building is well situated in extensive grounds of its own; the accommodation is ample, the drains are good, and there was no apparent reason why such an illness should occur. Further examination has pointed to a least suspected source. It appears the land is devoted to farming purposes; the surface is particularly level, the subsoil being gravel. When the school was built, a difficulty arose with regard to the disposal of the sewage, and a system of sewage irrigation was adopted. Pneumatic machinery was provided at great cost to pump the effluent, and everything seemed to favor the plan, which worked well, and gave no cause for alarm. One or two cases of enteric fever some years ago led to a close examination of the water from a well only 20 ft. deep at the rear of the building. This was tested at intervals, but without any result. At last Mr. F. Purkiss, the superintendent, took samples of the water immediately after heavy rain, which were sent to an analyst, who at once reported that the water must be condemned absolutely for drinking, for although "the total solids, chlorine, free ammonia, and nitrogen were not excessive, the presence of phosphates in considerable quantities, the bad smell of the water, and, above all, the great number of living and dead bacteria and other organisms pointed the water out as eminently dangerous."

This report set the school authorities to work; all the water was filtered, and an alternative supply from the Egham company's works, about four miles distant, has been obtained through an inch pipe. These measures were not taken quite soon enough, and symptoms of enteric fever ensued. From the evidence as published there is little ground to doubt the mischief has arisen from the well, which has been contaminated from the sewage-prepared ground, an opinion which Dr. Bridges, one of the local government board inspectors, has passed. The well is only 20 ft. in depth, and, as he observes, is open to suspicion under the circumstances.

This is no isolated case; we have heard of similar cases of poisoning before; sanitary and medical men are well aware of the danger of pollution to wells sunk in gravelly soils, which are treated by sewage, and yet we venture to say there are dozens of surface wells used for drinking purposes which are open to equal suspicion. Two things are plain enough: we should either not apply sewage to the land, or we should abandon altogether wells sunk in such soils. Advocates of sewage farms generally avoid the question of contamination, but it is one which cannot be shelved. If the conservators of the Thames have thought fit to apply certain standards to the water discharged from districts below the intakes of the water companies, there seems to be equal reason for applying a certain standard to the effluent of irrigation farms. The standards recognized by the conservators are that the defecated water should be free from offensive odor; free from suspended matters, or perfectly clear; that it should not be alkaline to turmeric paper, nor acid to litmus paper; that it should not contain per gallon more than 60 grains of solid matter dried at 260° Fah., nor contain more than three-quarters of a grain of organic and ammoniatical nitrogen per gallon, nor more than two grains of organic carbon per gallon, and that it should contain not less than 1 cubic inch of free oxygen in a gallon. These standards, it must be remembered, are only those recommended to preserve the river from being offensive to those living near its banks, and are not to be taken as rendering the fluid suitable for domestic purposes. We wonder how much purer the water is obtained from wells bored near sewage farms. In this last instance of the danger attending indiscriminate surface irrigation, there is another warning to sanitary authorities and those who obtain well water. A well acts as a drain to the soil in its neighborhood, and in this way is liable to contamination from every source. It may be near a drain or cesspool, and is liable to be infected. In passing through soil, it is true, organic matter becomes oxidized and converted into nitrates; but the process soon becomes defective, the oxidizing takes place imperfectly, and the soil becomes incapable of further purifying action. Such is the case wherever irrigation on the wholesale plan is tried, which, by overloading and saturating the soil, renders it a contaminating medium instead of a chemical filter, as it is when the doses are intermittent. Architects are concerned with this question of water supply, and may often—if they care to exercise their opinion—set their faces against all suspicious sites for wells, and take care that they are never placed near any receptacle for drainage, or near any sewage-farm, looking particularly to the natural dip of the ground or strata, and to its composition. Unfortunately, the evil reputation of impure water attaches to the house, the drains of which are suspected unfairly.—*Building News.*

BIOLOGICAL STUDY OF WATER.

IT is now generally admitted that the purity of water is in constant and inverse ratio to the number of the infinitely small organisms that live and develop therein. Until recent times it has been impossible to obtain an accurate idea of the number of these, and it has been scarcely possible to detect and recognize them with the microscope.

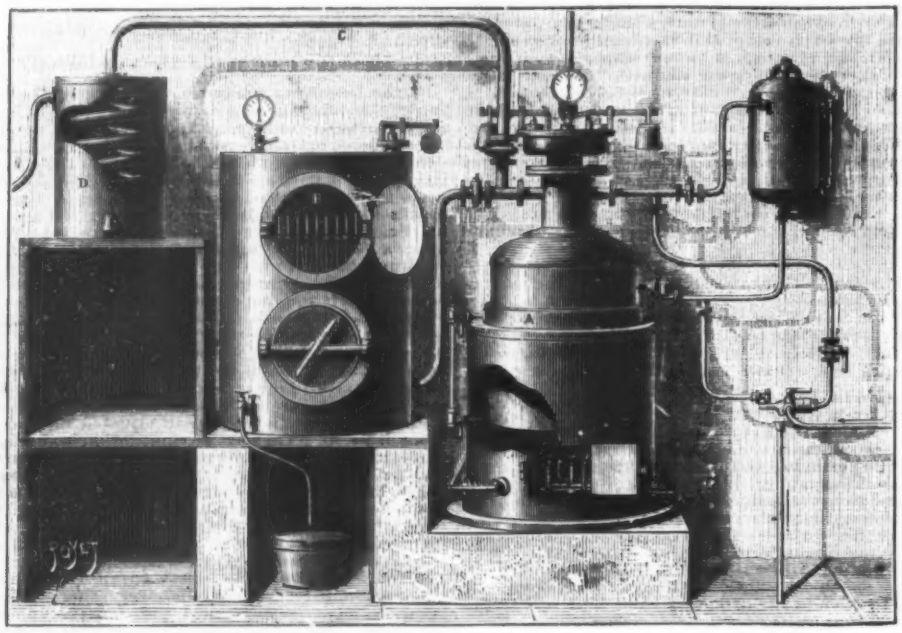


FIG. 1.—APPARATUS FOR STERILIZING MICROBES IN THE MUNICIPAL LABORATORY, PARIS.
A. Steam Generator. B. Steam Vessel in which the Microbes are Sterilized. C. Distilling Apparatus.

An apposite though imperfect method has, however, finally come to our aid in this line of research. If to a solution of gelatine we add a known volume of the water to be examined, and allow the solution to stand until it hardens into a jelly, we shall, after a time, observe a certain number of whitish points appearing in the gelatine. Each bacterium has reproduced itself and has become the parent stock of a colony of microbes, which appear under the form of an opaque point of varying size. These colonies develop in their turn, and finally completely liquefy the jelly upon which they have fed. If, before liquefaction, we count the isolated colonies, we shall obtain the number of microbes that live in the quantity of water introduced.

This process seems to be simple enough, but, when we come to put it into practice, we meet with difficulties. These, however, are more apparent than real, since they are easily surmounted by proceeding in a methodical manner. This is why we think it will prove of interest to describe in this place the method pursued in the municipal laboratory of Paris, for enumerating the number of microbes contained in water. Here they dissolve 600 grains of white gelatine and 30 grains of phosphate of soda in 28 fluid ounces of water, add the white of an egg beaten up in a little water, and put the mixture into a water bath and leave it there until the albumen coagulates, and then filter it. The perfectly limpid liquid obtained is sterilized in a digester at a temperature of from 115° to 120°. Thus prepared, the solution of gelatine keeps indefinitely without alteration. It hardens into a jelly at the ordinary temperature, and liquefies at about 30° or 31°.

Some of the solution is introduced into conical bottles that have a flat bottom (3½ inches in diameter) and are perfectly clean (Fig. 3). These bottles are then closed with a cork provided with two apertures, one of which is traversed by a glass tube plugged with cotton, and the other by a graduated burette that permits of the introduction of a quantity of the liquid to be experimented with. The bottles thus prepared are then put into a stove (Fig. 2), where they are heated by steam to a temperature of from 115° to 120° for 20 minutes. Thus rid of all germs, the bottles can be employed for examining water.

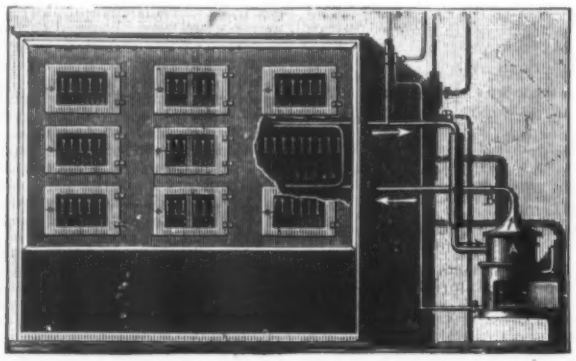


FIG. 2.—APPARATUS FOR BREEDING MICROBES.—A. Boiler. B. Hot Water Pipes.

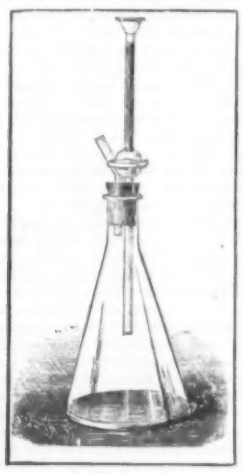


FIG. 3.

The water to be examined is diluted with 500 parts of boiling distilled water; then, by means of a small gauged burette, a known quantity of the dilution is introduced into the bottle, the gelatine in which has been liquefied by a gentle heat. The bottle is then put into a stove, where it is kept at a constant temperature of 24° or 25°. On the next day the small white points will be observed. The development of these is watched, and, when the number of them is no longer observed to increase (which will usually happen on the second day after their appearance), the number of colonies is counted. In order to prevent the same ones from being counted several times, the bottom of the bottle is divided into squares, or a piece of transparent paper so divided is applied to the bottom.

The number of colonies found, multiplied by 500, gives the number of microbes contained in a cubic centimeter. The bottle is then returned to the stove, and the day is noted upon which all the gelatine has become liquid.

The time necessary for the liquefaction varies with the nature of the living cells contained in the water, their number, the rapidity of their reproduction, the temperature, etc. In order that the results may be compared, it is necessary that the gelatine solution shall have always the same composition, and that the bottles shall be kept at the same temperature.

Certain waters that contain quite a large number of microbes liquefy the gelatine with difficulty, and there form upon the surface of the latter hard and perfectly limited points that spread slowly. Other waters, on the contrary, that do not contain any larger number of microbes, liquefy the gelatine with wonderful rapidity, and the colonies are observed to appear immediately after the sowing, and to develop and spread, and liquefy the gelatine in a few hours. These exhibit themselves in the gelatine in the form of small opalescent lenses having round or jagged edges. Microbes that act so energetically upon the gelatine are regarded as especially noxious and dangerous.

It now remains to describe the digester and stove in which the sterilization and culture are effected.

The former of these is a large iron stove having a capacity of about twelve cubic feet, and divided into two compartments 14 inches in height and 24 inches square. In order to heat it, steam is introduced into it under a pressure of two atmospheres, corresponding to a temperature of 120°. The steam is furnished by a generator of 22 gallons capacity, which is capable of supporting a pressure of 100 atmospheres and of furnishing steam for distillations in superheated steam. The generator serves, in addition, for producing the distilled water required for the laboratory.

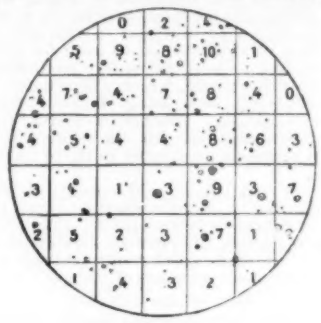


FIG. 4.

The fermentation stove (Fig. 2) is formed of three superposed compartments, and is heated by a thermo-siphon that passes to the upper part of the two lower-most compartments. The temperature is 24° or 25° in the lowest compartment, and 28° or 29° in the two others, and is kept constant by a D'Arsonval regulator that controls the entrance of the gas.

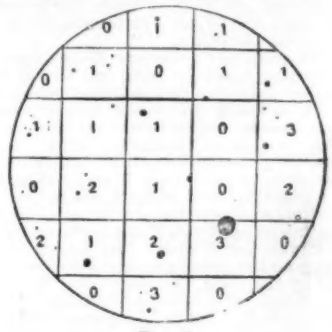


FIG. 5.

A USEFUL ACARIDAN.

THERE is a group of microscopic beings which is usually regarded as wholly noxious, and the name alone of which causes an itching sensation, and that is the one that includes the Acarus of the itch, *Sarcoptes scabiei*. In a special work, however, we have already shown that the Acaridans are far from being dangerous as a class, and that out of the three or four hundred species now known, there are scarcely a dozen that are capable, through the inoculation of a peculiar, poisonous saliva, of causing the development of psoric cutaneous affections, either in man or animals. All the others are inoffensive species that live upon vegetables, or the detritus of organic matters, or in the skins of mammals and the feathers of birds. Certain of these parasitic pseudo-Acaridans that live in skins or feathers are even carnivorous with respect to the other species with which they cohabit; and an example of these may be seen in *Cheyletus parasitivorax*, which lives in the fur of hares, where it hunts the *Listrophorus gibbus*, another inoffensive parasite of the same rodent.

There are, then, Acaridans that are useful in certain respects, and so we have formed a new category of them, which we call *auxiliary parasites*. Attention has been called at various times to certain Acaridans that live alongside of the phylloxera upon sickly vines, and that have been regarded as providential envoys charged with the destruction of the terrible parasite of the vine, in obedience to a law of harmony. Unfortunately, nothing has risen to confirm such a hypothesis, and our own special studies have permitted us to ascertain that these pretended enemies of the phylloxera are simply commensals that live upon the altered juice of a vine that has been rendered sickly through the stings of the subterranean louse.

There is, however, one Acaridan which might fulfill the role unduly attributed to the gamases and tyroglyphs, and which is frequently found in company with the phylloxera, since it is a born enemy of a large number of injurious insects, and especially of their larvæ and nymphs. This we have just studied in a memoir that has recently appeared in Prof. Robin's *Journal de l'Anatomie*. The circumstances under which we came to make this study were as follows: The green oak, in the south of France, is attacked by a coleopter, belonging to the group Buprestidæ, the *Coræbus bifasciatus*, the larva of which perforates the wood in all directions and finally causes the death of the tree.

Nymphs of this injurious insect had, at various times, been found dead in their galleries, having upon the surface of their body small spherical productions of a dark yellow color that were taken for the eggs of the *Coræbus*. Prof. Laboulbene, having received some of these dead nymphs, at first took these corpuscles for fungi, which they in fact closely resembled; but a closer examination with the aid of a microscope showed him that these little objects possessed, at one point of their surface, a head, a thorax, and feet through which they adhered to the nymph; in a word, it was an Acaridan. The Professor proposed to us that we should study this with him, and this study showed us that the

fungus-shaped body was really only the extraordinarily inflated abdomen (full of eggs) of an Acaridan that was affixed by its beak to the nymph of an insect at whose expense it lived, and of which it caused the death.

In the course of our study, and in making bibliographic researches to ascertain whether this Acaridan was or was not already known, we learned that it had already been seen in England, in America, and even in France (although imperfectly studied), and under the following circumstances:

Newport, while making his splendid researches in England upon the Hymenoptera, met this Acaridan

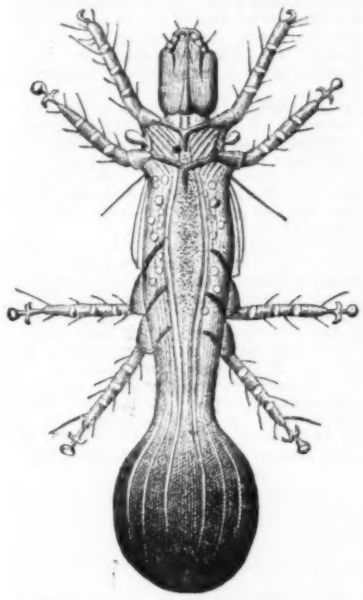


FIG. 1.—A FEMALE OF SPHEROGYNA VENTRICOSA.

upon a larva of *Monodontomerus*, which is itself a parasite of *Antophora retusa*. It thus rendered this bee the service of freeing it from a mortal enemy. Newport, struck with the extraordinary development of this Acaridan's abdomen, named the species *Heteropus ventricosus;* but he gave a very incomplete and even erroneous description of it, and inquired whether or not it might not be pathogenetic, as he had seen no male among the numerous specimens of females that he had had under observation.

Mr. Lichtenstein had found this Acaridan in the boxes in which he reared insects, and for six months it greatly interfered with his entomological studies by killing all his specimens. Without describing it, and believing it had not before been observed, Mr. Lichten-

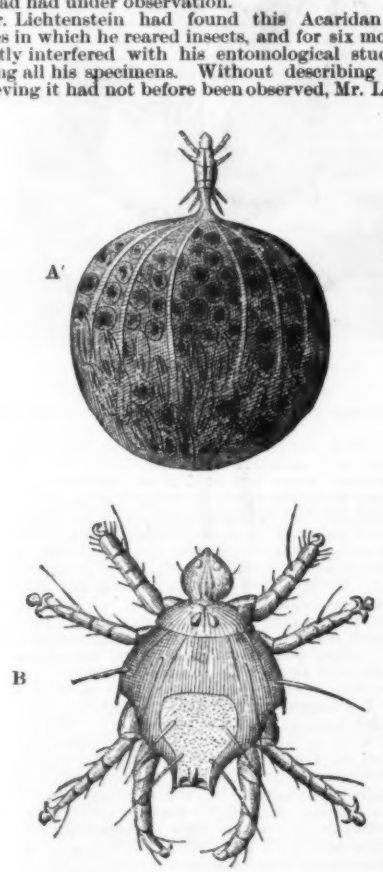


FIG. 2.—A'. FEMALE FULL OF EGGS. B. MALE.

stein named this destroyer of insects, provisionally, *Physogaster larvarum*.

Finally, Webster, in America, has pointed out the great services that this Acaridan renders to wheat attacked by moths, through its slaughter of these injurious microlepidoptera.

Although this Acaridan renders our granaries the service of ridding them of the larvæ of the grain moth, it has nevertheless some inconveniences, and that is, when there are no longer any insect larvæ to eat, it sometimes gets on the men who are manipulating the moth-attacked grain, and, through its bite, causes severe and insupportable itching. This fact was ascertained by Moissac near Montauban, where the Acaridan was named *Acarus tritici*, and compared with the Acarus of the itch. But its bite, although as severe as that of the itch mite, is more easily cured, seeing that its effect disappears after a simple bath.

In the complete study that we made of this Acaridan we found that it was through an erroneous observation that Newport attributed the name *Heteropus* to it. This name, moreover, cannot be preserved, any more than can *Physogaster*, it having been given several times to different insects. We have established for it the genus *Spherogyna*, and have preserved the specific name imposed by Newport.

We shall terminate this *resume* by saying that, through the organization of its beak, which includes three styliform mandibles and maxillary palpi with three articulations, the end one of which is provided with a hook, and through its tracheal respiratory apparatus, this Acaridan belongs to the family Trombidicæ; and that, through its doubly grouped feet, each composed of five articulations ending in hooks, simple in the first pair and double in the following, where they are accompanied with a spatulate caruncle, it must be referred to the tribe Cheyletidæ, and be placed in the vicinity of Haller's genus *Picobia*.

This Acaridan is remarkable for the rapidity with which it develops and multiplies. The female has its large abdomen stuffed with eggs, which develop through the complete assimilation, without residue, of the nutritive juices of which it has robbed its victim. Some of these eggs yield males, and others females, which are perfect and adult when they come from the mother, and which at once become fertile without having to pass through the larval or nymphal stages as other Acaridans do. This explains its rapid multiplication when there is an abundance of prey.

In Fig. 2, A represents a female in the most active period of reproduction, with an abdomen that has centupled in size, and that is full of eggs; B represents a male, the individuals of which are very rare, and are very much smaller than the females—a fact that explains why they had not been observed up to the present.

One male must suffice for several females, and these he fertilizes in measure as they come from the mother's body. Fig. 1, A, represents a female that has just been fertilized and the abdomen of which is beginning to swell.—*P. Megnin.*

[BULLETIN OF THE CHICAGO ACADEMY OF SCIENCES.]

THE NORTHERN PITCHER PLANT, OR THE SIDE-SADDLE FLOWER, SARRACENIA PURPUREA, L.

By W. K. HIGLEY, Seminary, Lake Geneva, Wisconsin.

THAT insects are of great use in the vegetable economy is a subject of much interest to many scientific minds of the present day, causing many investigations resulting in experiments that are leading us into a deeper and truer knowledge of the physiology of plants.

These investigations are transforming many theories into facts; many mere fancies into realities; many of the so-called "freaks of nature," of the older writers, into useful adaptations for aiding in the development of the plant. It is now obvious, even to the slack and unscientific observer of nature's laws and methods of work, that the insect world is necessary for the proper growth and propagation of many species belonging to the vegetable kingdom.

It is well known to the intelligent agriculturist that many of the plants used in our economy could not even mature their seeds unless aided by insects, notably the hive bees. The beautiful orchid family is a grand illustration of the usefulness of insects in fertilization. Dr. Charles Darwin has shown that each part of the flower is adapted to this end. It seems as if, in this family, nature truly abhors self-fertilization, and in some species, though giving the plant all the parts of a hermaphrodite, yet arranging them so that only an insect can bring about the proper relations for propagation. Our melon, pumpkin, squash, cucumber, and gourd plants are also worthy of note in this connection.

"The flowers" of these "are each furnished with a long or rather deep corolla, and the plants often lie flat on the ground, where the leaves cover the flowers from the action of the wind. Bees and other insects are the necessary agents in crossing the flowers," for they are either dicecious or monœcious, "and to them we are indebted as one of the links in the chain which affords all our gourd-like fruits."

To this division of Entomophilous species belongs the plant under consideration in this paper. All the species of the genus Sarracenia are constructed in such a manner that in fertilization they are absolutely helpless without the aid of insects. The large umbrella-like expansion of the style, which is stigmatic at the termination of the five rays, completely hides the stamens, which are decidedly below it and shielded from the wind.

A still more peculiar use of insects to the vegetable world is that of a food, and many plants are specially fitted for catching and using the material of their bodies for nourishment.

Perhaps the most striking of all these plants are the pitcher-plants, some of which throw out a honeyed secretion which, trickling down the wing of the pitcher, forms a baited pathway to attract the unwary insect to the inside of the pitcher.

The genus Sarracenia, to which the plant under consideration belongs, is one of the three genera of the order Sarraceniaceæ. The species of all the genera are natives of America and chiefly of the United States, the genus Heliamphora being a native of Venezuela. Mr. Sereno Watson* makes the following enumeration of the species of the other two genera, Darlingtonia and Sarracenia:

Darlingtonia Californica, Torr.
Sarracenia Drummondii.
" flava, L.
" psittacina, Mx.
" purpurea, L.
" nigra, Walt.
" Sweetii, D. C.
" undulata, Denie.
" variolaris, Mx.

All the species have root-leaves, and, excepting the genus Heliamphora, have terminal scapes bearing a single flower. The exception has a scape bearing a few-flowered raceme. The leaves are all hollow and more or less pitcher-shaped, with a hood at the upper part, and a wing, that is often very broad, upon one side.

As to their position in classification, this family† quite closely resembles the poppy family (Papaveraceæ) on the one hand, and the water-lily family (Nymphæaceæ) on the other. It is related to the former by the character of its petals, numerous stamens and seeds, capsular fruit, copious albumen, etc. It is connected with the latter by nearly the same characters,† and also by having all the leaves from the root, a one-flowered scape, and more or less aquatic habits. The poppy family differs in habits, juices, in having but two or three sepals and a one celled ovary. The water-lily family differs in having, usually, numerous petals, in the attachment of the seeds and the sessile stigmas.

By certain analogies the pitcher-plants are closely related to the sundew family (Droseraceæ) and the Asiatic pitcher-plant family (Nepenthaceæ.)

A microscopical study of the minute structure of the families mentioned not only confirms the close relationship existing between them, but also adds new facts to those that appear from a study merely of the external characters of their representative species.‡

Our Northern pitcher-plant is, perhaps, the one of greatest interest to the people of the Northern States.

It is by far the most common form of the genus, extending in its range over the States east of the Mississippi and north from Florida far into the British Possessions. It is not so elaborate an insect catcher as some of the more Southern forms which have already been spoken of as throwing out a honeyed lure which attracts numerous ants, an insect rarely found in our species.

The pitcher leaves (Ascidia) of the side-saddle flower, as well as those of all the family, are evidently phyllodia. They have the parallel veination of petioles acting as blades, and the edge is invariably turned toward the sky. The hood may represent the blade of the leaf. The wing forms the greater part of the young leaf.

Inside these pitchers are found hairs, which cover more or less of the inner surface. Those which cover the hood continue to or a little beyond the junction with the tube. Following this area is a smooth surface which extends to near the point where the leaf begins to contract, when a patch of less stiff hairs are met with. This time they extend into the narrower portion of the tube. All the hairs point downward.

The position and form of these hairs, especially those on the hood and upper part of the tube, and in fact any that may be above the fluid, in the lower part of the leaf, would show that their function, in part at least, is to prevent the escape of any insect that may have entered the tube. The hairs in the lower part of the tube probably act to some extent as absorbents of the nitrogenous matter decaying within the leaf. Some acute observers claim that at the end of each hair there is a minute opening, thus allowing the nitrogenous fluid to pass directly into the apical cell of the hair. This does not seem to be the case, but instead the wall surrounding the entire cell is very thin. These hairs are simply trichomes, that is, they are rather cells than organs. Unlike the tentacles of the sundew, in no case do the spiral bundles enter their tissue. I am inclined to believe that these cellular hairs serve more than one purpose in the economy of the plant.

A study of the structure and physiology of the whole family shows that all the forms need a great deal of absorbing surface, for there seems to be a lack of stomata. The tissue of the leaf is almost constantly gorged with a large supply of nourishment consisting, evidently, of absorbed nitrogenous matter, and needs a great extent of surface exposed to the air for the purpose of absorption in carrying on the functions of assimilation and metastasis. In support of this there is considerable evidence, the most important of which is the fact that many of these hairs, especially those on the hood, contain chlorophyl. From a study of marked leaves through the whole season, I am led to believe that some of the hairs are absorbed as the leaf grows old. This would indicate that as the functions of the leaf are lessened the extent of absorbing surface is reduced.

When the leaf has apparently nearly stopped absorbing the moisture from the tube, it may still be an active insect trap. At this time an especially strong odor is given off from the decaying mass of insects. It would seem that the insects caught now could be of no use except as a fertilizer, when, by the decay of the leaves, all this mass of decomposing nitrogenous matter is deposited around the roots of the plant. The decaying material, moreover, seems to hasten the decay of the leaf, as its vitality is lessened, by the advancing season.

* Bibliographical Index to North America Botany, by Sereno Watson, Smithsonian Miscellaneous Collections.

* General System of Botany, Le Maout and Decaisne, p. 212.

† The water-lily family in some of its forms has a definite number of stamens.

‡ Since the writing of this paper, Mr. J. F. James has published a very interesting article on "How the Pitcher-Plant got its Leaves." (American Naturalist, vol. xiv., p. 567.)

After tracing the apparent gradation of adaptability for taking insect food existing between the species of the genera of Sarraceniaceæ from the less marked trap and imperfect pitcher of Heliamphora through the genus Sarracenia to the remarkable trap pitcher of Darlingtonia with its attractive appendages, digestive fluid, and sweet lure, Mr. James says: "Scarcely any of the steps showing the progress are needed to complete the line of development. It can be traced directly from Heliamphora to Darlingtonia, and it is only necessary to have an ancestral form from which to start to have a complete pedigree. It seems probable that the water-lily family and the pitcher-plant family had a single ancestor in common. This ancestor was aquatic, or at least an inhabitant of swampy places. It had small, probably peltate, perhaps reniform leaves, and these had hollow petioles. The inner space was lined with hairs as are now the inner surfaces of the stems of Nymphæa and its allies; it had a four or five parted flower, with many stamens and a broad stigma. From such an ancestor came two or three branches. One of these developed into plants having an aquatic habit, large leaves and long petioles, and peduncles like those which are found at present in the water lilies. The other branch diverged to form plants living in boggy or swampy grounds, with pitcher-like leaves, whose insectivorous proclivities were developed later on."

Mr. James suggests that these proclivities were developed by a true process of natural selection. The more or less saucer-like peltate leaves may possibly have held some water in which insects were drowned. This fluid, by causing the decay of the blade at the insertion of the petiole, found its way into the hollow petiole, and finally by absorption of the nitrogenous matter the plant gained nourishment that could be used in its growth. This adaptation being of use to the plant might lead in the next generation to leaves better fitted for taking food in this manner. This in course of time would give rise to a generation of petioles peculiarly adapted to catching water and insects by being pitcher-like in form. The blade, no longer needed for absorption, would become a mere rudiment, and then would follow the further process of perfecting traced by Mr. James in Sarracenieæ.

It is noticeable that there are many insects around the leaves just at twilight or when the sky is overcast with heavy clouds. Remains of nocturnal insects are also very common in the macerating mass. This seems to indicate that flies and other insects seek the hollow leaves in which to retreat during the hours when they are naturally at rest. It is a fact that insects seek retreats of this kind.

True to the habits of the spiders to seek those places for their homes that flies frequent, there is one that makes its home at the top of the leaves, spinning its web so that it nearly covers the whole opening. In each case that I have observed it is the same species, but whether it always seeks the pitchers I cannot state.

An insect lighting upon the leaf starts immediately to walk toward the inside. It seldom stops till the smooth place is reached, where sooner or later it loses its foothold and falls. In some cases they try to fly upward from the bottom of the pitchers. In but one case have I seen an insect escape in this manner. This, a beetle, obtained its freedom by flying from one side of the tube to the other till the opening was reached.

A slight secretion has been observed by many near the opening of the pitcher. This seemingly has but little power to attract insects, though at times it is quite copious.

Mr. Joseph Jackson says:* "While collecting a few specimens of S. purpurea, L., I was surprised on drawing aside the petals to look at the stamens to see the whole cavity formed by the petals and the peltate expansion of the style filled with flies as large as the common house fly, all busy as could be eating the pollen, of which scarcely a grain could be seen. I counted fourteen flies in one flower. They were in no hurry to vacate the premises. There was a shower coming up at the time, but they were evidently there for food. Nearly every plant examined was filled in the same way."

Mr. J. F. James suggests† that perhaps "there is something in the pollen, or in some secretion of the flower, which has the effect of stupefying or intoxicating the insect, and that then they might easily be shaken from the flower, by the wind, into the open mouths of the rosette of leaves below."

My observations differ somewhat as to the usefulness of these insect visits to the flowers. There are two or three species of diptera found in the manner described. They are evidently attracted to the flower by some property of the pollen or a secretion of some other part of the flower, but it would seem mainly for the purpose of aiding in fertilization, for a lens reveals the fact that pollen is quite freely scattered over their backs. Moreover, these plants flower during the latter part of May and the first of June, while insects are caught during the months of May, June, July, and August. Though without question some of the flies from the flowers do eventually find their way into the pitchers underneath, yet these species are not nearly so common in the decomposing mass as some other species. Some time was spent in taking notes as to the effects of this food upon the flies, but without any results showing stupefaction.

The great question is, What purpose do the decaying remains in the bottom of the tube serve in the economy of the plant? In order to decide this question, it will be necessary to know the chemical nature of the fluid found in the pitchers. Several chemical analyses were made under as widely different conditions as a limited region of the country would allow. As a result of the examination of over eight hundred leaves, I find that none contained any fluid before they had opened. These were collected from several localities. After opening, there is no fluid till after the first rain, except in a few cases when there has been a heavy dew.

The oldest leaves to be found were in each case selected, and it is thought that in all cases they were the growth of the season up to date. In preparation the leaf was cut open and the contents removed to a crucible, but in no case was the mass used unless of such a consistency that it would flow easily. The reaction was acid in each case, but the degree of acidity increased each month, and was very marked through July and August. To just what acid, if any particular one, the reaction was due in the liquid of the earlier pitchers is not certain, but in the last two months both malic and citric acids appeared, the former in greater abundance.

The analysis of the ash and the residue of the filtered and evaporated fluid was qualitative. The object being simply to see if there was any relation existing between the inorganic matter contained in the fluid and the surrounding soil, etc., it was not minute. In each case, where it was possible, the soil near by at all liable to get into the pitcher was analyzed. However, not all the inorganic salts could be accounted for as from the soil. Whenever it was evident that the inorganic matter was similar to the soil near the plant, it is indicated by giving the character of the surrounding soil.

It seems highly probable that the first lot of insects merely decay after maceration in the water first collected in the pitchers, and that this mass acts not only as a stimulant to further decay, but also to render the liquid more capable of absorbing certain organic principles from the leaf, such as malic acid, which aid in the preparation of the abundant supply of food for absorption by the leaf. Thus the first mass might be called a digestive excitant. There being no glands, the process of exciting the leaf to the secretion of an acid would be quite slow.

That this is the case, I feel assured by the fact that absorption evidently takes place much more rapidly during the last days of June and the months of July and August. It is then that much nutriment is needed and the cells are filled with matter. The large tubular cells in the structure of the lower part of the pitcher walls and in fact those extended downward into the root are at this time charged with matter, while earlier they are comparatively empty, though much nitrogenous matter has been in the leaves for several weeks.

By a set of experiments it was easily shown that the ammonia contained in the liquid, either having its source in the rain water brought to the plant, in the results of the decomposing remains of the insects, or in the absorption from the atmosphere, was readily and quite rapidly absorbed by the leaf.

In these experiments it was assumed that but little would be absorbed by the liquid from the air, during the season of experiment, especially if it was a dry time. Such a time was therefore selected, and the leaves so turned and propped that no rain could fall unto them. The leaves marked were those that contained but few insect remains. Two in each case were examined from each plant. Great care was used that both should have the same age, amount of liquid, and nearly the same amount of remains, and especially that they should have as near the same size as possible.

One leaf was marked and treated as above, while the fluid of the other was immediately tested for organic ammonia and the amount estimated. At the end of a week the marked leaves were picked, quickly examined, and the fluid analyzed for organic ammonia. The fluid showed a decided decrease in each case, from the amount found in the one used in comparison. Though these analyses were perhaps quite far from sure in every detail, yet the average difference on comparison, viz., sixty parts in one hundred, would indicate quite rapid absorption, for such an amount could not possibly be removed in any other way.

* *Bot. Gazette*, vol. vi., No. 7.

† *Amer. Nat.*, vol. xvii., p. 284.

THE LAPPS.

As well known, northern Scandinavia is inhabited by a race of men who differ considerably from their neighbors, and these are the Lapps. These people do not know this name, but call themselves *Sabme* or *Same*, plural *Sameh* or *Samelats*. They call their country *Same-Adnam*. The origin of the name Lapp, as well as its etymology, is obscure, and the word is cited in no document previous to the twelfth century. The Norwegians always call the Lapps *Finner*, 'Finns,' and it is thus that they are designated in the most ancient Scandinavian documents; hence, the name of the most northerly province of Norway—*Finmark*, the country of the Finns.

FIG. 1.—LAPP MAN.

FIG. 2.—LAPP WOMAN.

Lapland, the territory occupied by the Lapps, is divided between four States, viz., Norway, Sweden, Finland, and Russia. The area of the Lapp territories and their population is given in the following table:

	Area.	Population.
In Norway	16,049 sq. miles	15,718
" Sweden.....	48,830 " "	6,404
" Finland.	26,125 " "	1,038
" Russia.....	60,610 " "	2,207
	151,614	25,367

The documents that we possess do not permit us to say whether the Lapps are diminishing or increasing, but there is one fact that is certain, and that is that the number of *pure* Lapps is considerably decreasing, for marriages between them and the Finns are very numerous in the north of Scandinavia. These Finns are slowly invading the Lapp territories in Sweden and Norway. The Lapps, who before the invention of steamboats lived almost outside of European civilization, have been gradually driven toward the north by Scandinavian colonists, who are settling upon territories of which they were once sole masters.

The Lapp is small, the mean height of 200 individuals being 5 feet for men, and 4·8 for women; he is brachycephalous; and he is round-faced. His cheekbones are very prominent, his eyes are small and deep set, and their color generally varies between the two first lines of Broca's chromatic table. His eyelashes are few, and often wanting, removed as they are by affections of the eyes to which these people are subject from living in a smoky atmosphere.

His eyesight is very good. His nose is quite small and pointed, as shown in Fig. 1. This at least is the type that we have oftenest observed. Its profile varies between Nos. 2 and 3 of Broca's instructions. The mean nasal index is 74·59 for men, and 73·64 for women (Fig. 2). The Lapp's mouth is large, the mean being above 2 inches in 120 individuals. His lips are straight, and his teeth are vertical and often worn away. His chin is pointed, and his hair is long, wavy, black, and shining. Many Lapps become bald early; they have but little beard, and what they do have is scattered. The color of their skin varies between Nos. 24 and 26 of Broca's instructions. It is often darkened by the smoke in the midst of which they live, and by the dirt with which they are usually covered. Even the young people have numerous wrinkles, which, added to the characters already cited, make them appear prematurely aged. Their voice is strong and clamorous. Their legs are generally small, the proportion of the sitting to the upright posture being in 112 subjects 52·9 for men, and 52·98 for women. But appearances are often deceiving, since the Lapp generally stoops when walking. On account of his poor food, the Lapp is usually thin, but his muscular system is well developed. He is strong and agile, and is a great walker. In winter it takes him but a short time to get over great distances on the ice by means of his skates. In 1884, five Lapps, in one journey, made 136 miles with a mean speed of more than six miles per hour.

These people enjoy good health, but lose many children for want of care. Morally, the Lapp is gentle and peaceable, and often tries to gain his point through strategy. Although each individual has a knife with him continually, he rarely has a bloody altercation. His language has much affinity with the Finnic, but the two peoples are very different from a physical point of view.

Formerly the great majority of Lapps lived in a pastoral state, and raised immense herds of reindeers, which furnished them their food (meat and milk), and which served them as beasts of burden. These, along with a peculiar variety of dog that aided them in guarding their herds, were their sole domestic animals. Their state might be characterized by saying that they were in the age of the reindeer. But now, on account of the difficulties created by the Scandinavian colonists apropos of reindeers, many Lapps have had to give up their nomadic life and their herds and became sedentary. There are at present two sorts of Lapps, viz., the mountain Lapps (Norw. *Fjeldlapperne;* Swed. *Fjalllapparne*) and sedentary Lapps.

The former are those who have preserved their nomadic life, and who live with their reindeers. In entire Lapland, there are still about 400,000 reindeers. In winter, when the earth is covered with snow, these Lapps inhabit the valleys, and live in tents made of a few rods covered with a woolen fabric, which in summer is replaced by linen. In the center of the tent there is a fireplace. The dogs lie pell-mell with the entire family. For traveling in the winter season they use sleds drawn by reindeers. In this manner they get over a very wide space in a very short time. Their food consists of game, coffee, and dishes made of milk. They formerly drank much brandy, but it is now against the law to sell this to them.

The winter costume of the Lapp consists of a sort of large fur blouse fastened at the waist by a belt, from which hangs a knife in its sheath. His head is covered with a gaudy colored cap, which is either square, as in Norway, or pointed, as in Sweden. His foot covering consists of a pair of waterproof leather shoes called *komager*. In the interior of these is placed a species of herb to support the foot. The lower extremity of the trousers is tucked into the leg of the shoe and tied with strong ribbon. A pair of gloves completes this costume.

The women's dress is about the same. For walking upon the snow they have a pair of snowshoes two yards in length, and to help themselves along they hold in the hand a large stick that has an enlargement at one of its extremities to prevent it from sinking into the snow. When summer comes, and the valleys are changed into swamps, where swarm mosquitoes that are insupportable to the reindeer, the Lapp, who can no longer use his sled, loads his tent and furniture upon the back of his reindeers, and departs for the pasturages on the high plateaux. The women carry their children upon their back in wooden cradles. Summer is the bad season for the mountain Lapp.

As for the sedentary, fishing, forest, river, etc., Lapps, they have partially adopted the life of the Scandinavian fishermen and peasants. They construct either wooden houses (in which the windows are sometimes

ornamented with glass) or *gammers*. These latter are small, low houses, made of wood and covered with earth and turf. Herein are often seen stoves.

At what period did these people come to Lapland? Whence came they? What is their relation to other analogous peoples? These are questions that cannot now be answered. One fact appears to be certain, and that is that the Lapps came from Central Asia, where they had been in contact with other peoples, who still have affinities with them. Their migrations have taken place through the north, for their language possesses no words that belong to it for designating the objects of a more clement clime. As an offset, they have a host of designations or the different forms of mountains and the different states that snow and ice assume. Another fact nearly as certain is that the Lapps entered Scandinavia through the northeast, and not by the south, as some authors have stated.

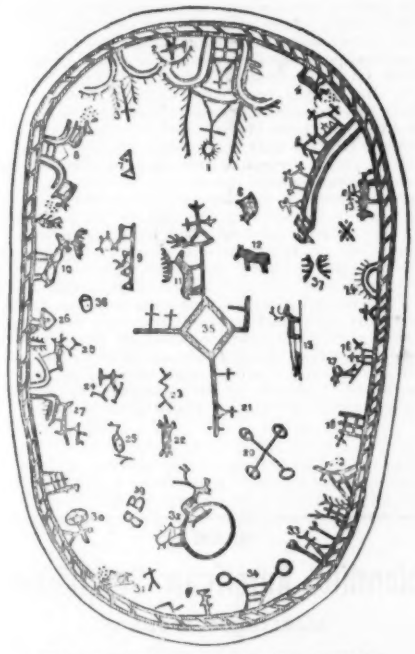


FIG. 4.—HEAD OF MAGIC DRUM.

A century ago the Lapps were still pagans, but now they are all converted—in appearance at least—and have almost forgotten all their ancient practices, which, in the middle ages, made them pass for great sorcerers, whom people came from afar to consult. Their sorcerers, who were called *noaides*, predicted the future through the use of a magic drum, an object that these people no longer use, and which has consequently become very rare. This drum consisted of an oval wooden frame, from 12 to 16 inches long, over which was stretched a skin ornamented with figures representing different mythological subjects.

In order to predict the future, there was placed on this drum a ring of brass or copper wire about one-quarter inch in diameter, called a *vuorbe* or *veiko*. This ring, which represented the sun, bore several other and smaller ones, that represented the rays. This index was always placed in the center of the drum, where there was a figure of the sun. The sorcerer provided himself with a sort of Y-shaped hammer, made of reindeer's horn, and tapped the drum gently, so as to cause the index to travel over the surface of the instrument (Fig. 3). According to the route that the index took, and to the figures at which it stopped, he deduced such or such a consequence for the questions that had been asked him. It is useless to say that the sorcerer had a special knack of moving the ring in whatever direction he desired. Every one knows the adventures of Reynard with the Lapp sorcerers, and what he tells about them.

Fig. 4 represents the surface of a magic drum, now in the Ethnographic Museum of Copenhagen, which the writer photographed during his last visit to that city. The following is an explanation of the signs upon it:

1. Radien-acce, the chief of Lapp gods. 2. Radien-bardne, son of the preceding. 3. Radien-Akka, wife of No. 1. 4. A horse. 5. Restbalges, the road of Christians. It is bow-shaped, in order to show that the latter often dwell upon declivities that the Lapps are obliged to climb in order to get at them. Upon this road are placed the Christian attributes, a goat, a house, a church, and a peasant and his wife. 6. A boat. 7. A Lapp tent. 8. A wolf that has stolen a reindeer. 9. A reindeer belonging to other Lapps. 10 and 11. An elk. 12. A bear. 13. Rota on horseback. 14. The sickness that follows Rota. 15. Lapps traveling. 16. Rota-Aibmo; his abode in the other world. 17. Offerings to Jabmi-Aibmo. 18 and 19. House and church in Jabmi-Aibmo, the kingdom of the dead. 20. Net employed by the sorcerers. 21. Lapp casting a net. 22. Noaide-lodde, sorcerer's bird. 23. Sorcerer's fish. 24. Lapp hunting. 25. Fish pond. 26. Stabur, a wooden house used by Norwegian peasants as a store. 27. Fjelds upon which the reindeers roam. 28. Dam for closing rivers for salmon fishing. 29. Lapp gammer. 30. Noaide with a magic drum. 31. A hog. 32. Reindeer pen. 33. Sarakka, mother of creation. 34. Jabmi-Aibmo, kingdom of the dead. 35. Baeivve, the sun. 36. The moon. 37. Saivvo-Sarvak, reindeer in the subterranean world.

It will be seen that the sorcerer could give his imagination full sway in combining these signs.—*R. Bonaparte, in La Nature.*

A TALK ABOUT GEOLOGY.

THE word geology is made up of two Greek words meaning "earth-wisdom."

All science, all knowledge, is but the working out of common sense with reflection, patience, and care. And geology is but the working out of the surface history of the earth and of the life history of the animals and plants upon it in a common sense way; for my readers must know that the soils, rocks, mountains, valleys, lakes, rivers, and oceans of the world have a history as certainly as men and nations. And as empires and kingdoms once have been which now have passed away, so in former ages of the world have various kinds of animals and plants which now no longer exist had dominion on the earth, each for very long periods of time.

In short, the world that now is was not made about some 6,000 years ago, as in a work-day week running from a Monday through the Saturday following. Nor are the animals and plants that now are those whose kinds appeared in the first six days of time.

"How are these things known to be so?" I can best answer by illustration.

Suppose some men are seen at work in a field. A ditch is being cut. Some men in advance are breaking the soil with pickaxes; back of them others are throwing out the loosened soil with spades; deep down in the earth others still are removing the last portions from the bottom; but back of all the men in sight a line of ditch already cut is seen to stretch away several hundred feet. Now, there can be no doubt that these several hundred feet of ditch have been cut substantially in the same way as the ditch is being cut where the men are seen actually at work; so, if part of the earth is seen in the act of being thrown into a cart, and at a distance another cart is seen in the act of discharging its load on a heap of fresh earth, there being marks of wheels from the one place to the other, I think there would be no difficulty in agreeing that the fresh earth already down there at that heap had come from that ditch substantially in the same way, by digging and carting, although the process had not in fact been seen. Again, in walking over the fields one comes across a mass of bone; it looks exactly like the skull of a horse or a sheep, as the case may be. There can be no doubt but that this mass of bone was once the skull of a living horse or sheep, which, having been born, grew up and died. Again, in walking through a forest one meets a great oak tree many feet in height, and there close by a tiny oak sprout just above the ground, just enough of it to say it is an oak sprout. There can be no doubt but that this great oak tree was once just such a little sprout as that, and that it took time for that great oak tree, year by year and year by year, to lift its head, to send out a branch here, a twig there, until now, perhaps after five hundred years, it has its thousand branches, its tens of thousands of leaves, and its head way up there under the blue sky in the open sun light, rejoicing in the vigor of mature age.

Now, in geology common sense argues much in the sort of way I have been describing. Common sense sees digging, carrying away, and depositing going on in nature; it finds rocks and soils in the making; it finds animals and plants being buried and preserved; it finds that this is going on from day to day, and that it takes time for all these things to be done. When therefore it finds rocks and soils already made, when it finds the remains of plants and animals sealed up and preserved in these soils and rocks, it argues that these things were done of old, and that it took time to do them in, although it has seen none of them being done. From what it sees it argues the unseen. Just as no one would say that the ditch, the heap of earth, the skull, the great oak tree, were created of a sudden just as they were afterward seen, so geologists do not believe that nearly one hundred thousand feet of stratified rocks with their contained bones, shells, and forms of the parts of animals and plants that apparently once lived, and of kinds different from those of our times, were made in any six days of time. Just as it takes time for a ditch to be dug, for earth to be carted away and deposited; for a horse or a sheep to be born, to grow, to die; for an oak to reach its height: so does it take time for the surface of the earth to be made and remade over and over again, and for animals and plants to have come into being, to have lived, and to have become preserved in the earth, to be succeeded by others of different patterns having like histories.

Let us consider how the surface work of the earth is being done from day to day. First of all there is the rain.

As soon as the rain drops strike, they begin their work; for carbonic acid gas entangled in the drops gives them power to dissolve and wear the rocky and stony surfaces which they wet. Something, too, must probably be allowed for the tiny shock of the descending drops, as with the blows of a million little hammers the projecting corners and edges are bit by bit knocked off, and cracks and fissures made. The small dust grains and the larger fragments that fall away are bit by bit carried, rolled, and dragged down by the waters as they descend; for the least slope will cause the slippery waters to run down and down. The drops collect in thread-like streams or thin sheets; these in turn meeting, make rivulets; rivulets meet in torrents; these rush into the rivers, and the rivers move on to the seas. Such is the course of the surface water.

Another portion of the rain finds its way through the soil, through the cracks and crannies of the rocks, and even slowly wets and passes through their solid substance; for by far the greater number of building stone are much softer in the quarry than after being taken out; once dried, though immersed again they will not become soft. This mining water carries down with it the entangled carbonic acid gas, and so may dissolve out portions of the rocks as it goes down; or descending low to the hot interior of the earth, become itself heated or perhaps even converted into steam, and so act the part of a mighty solvent; for very hot water, especially if alkaline, can dissolve out even silica from the rocks, as is seen in the case of the geysers of Iceland. This mining water coming to the surface or bursting through the hillside creates the springs whose waters may be thus deeply charged with many a mineral substance in solution or in the form of solid matter. The springs feed the rivers, and the rivers carry down the contained minerals on toward the ocean.

Now, all this moving water carries away the soil and grinds the rocks to powder; for consider that as it falls to the seas it must carry down the dust and rock fragments which are not too heavy for the rushing waters. With such dust and pebbles and rock fragments as it can move it hammers and pounds, rubs, polishes, digs, and cuts away the sides and bottoms of the beds in which it flows. The larger fragments are worn down by use and by the blows of the faster-moving pebbles and dust which strike against them, so that at length the rocks are worn down to rounded masses and dropped in some hole of the stream where the current is too feeble to move them, or ground bit by bit to dust and taken far out to sea, or in time of flood lodged above the general level of the stream.

To impress on our minds the work which the rain accomplishes, let us consider the case of three great rivers—the Niagara, the Mississippi, and the Colorado.

The Niagara River flows in a ditch cut out of limestone and other rocks for seven miles. This ditch is from two hundred to three hundred feet deep and from six hundred to twelve hundred feet wide, and there cannot be the least doubt but that the river has cut away all that mass of rock for itself. All that great body of rock has been worn down by the rush of the waters (and by the frosts), just as the Falls are now wearing back slowly toward Lake Erie. Just realize the fact of this great mass being ground down and broken to pieces, and carried part into Lake Ontario, and part out into the Atlantic Ocean by way of the St. Lawrence, and you will admit that time is long.

The Mississippi carries into the Gulf yearly solid matter enough to fill a space two hundred and sixty-eight feet deep and one mile each way. The delta of the river has been built by the river itself, and has been advancing out into the Gulf yearly. At the southwest pass, or principal outlet, the sandbar built by the fine material which (before Capt. Eads' day) was dropped by the current as it lost its velocity (checked by the waters of the Gulf) was re-excavated by the current and redeposited each year further out, advancing in this way at the rate of three hundred and thirty-eight feet a year over a width of eleven and a half thousand feet.

The Colorado like the Niagara has dug its own ditch, but the work is gigantic compared with that of the Niagara; for the channel is three hundred *miles* long and from three to six *thousand* feet deep, five hundred to a thousand of which in some places has been cut out of solid granite. Besides the main channel are the immense numbers of side channels or canons of equally profound depth. The country is so cut up by this enormous system of nature's ditching that it is said only a bird can really travel *over* the country.

The rains then work as with pickax, with spade, and with cart, mining, digging, and carrying away,

FIG. 3.—LAPP SORCERER PREDICTING THE FUTURE WITH A MAGIC DRUM.

until the solid rocks are broken down and the land threatens to disappear beneath a universal waste of tossing waves.

Ocean also wars against the land unceasingly. The soil cliffs are quickly undermined, and the fallen fragments pulled to pieces by the batteries of the waves and currents. The rock-bound coasts stand as a wall of defense for much longer periods; but the waves are tireless, charged with sand or pebbles (the wear of ancient cliffs torn bit by bit to pieces in the same way) the waters hammer and pound the rocks, drag, rub, and roll the fallen fragments about till the fine resulting dust is thrown upon a beach or carried out to sea, and slowly dropped to form the rocks of future ages. So the sands and rounded pebbles of the beach are formed. Here again great sweeps of time must be demanded for the accumulated masses of the waste material of the rocks thus slowly ground down by the tireless tossing waters.

But we are by no means done with water. In freezing, water will have elbow room for itself, and so the rocks are rent, little chips and great fragments hurled off by the frost. The snows in some parts of the world falling on the mountain tops and slopes by the weight of the material from time to time added above and behind, become compacted into great sheets and masses of moving ice, the glaciers. These slowly advancing into the valleys, much below the limit of perpetual frost, when melted give rise to rivers. But before they melt they do work. Dust storms give rise to a considerable amount of rock matter which falls upon them. By the meltings of the snows little streams rush down the mountain sides, and pour upon the glacier such soil and rock fragments as they have chanced to bring down. Large pieces of rock are detached by the frost, and fall on the glacier from the sides of the valley in which it moves. Besides all this quantity of rock rubbish, the glacier holds firmly set in its substance, in its sides and on its bottom, dust and pebbles and rock fragments, with which, as it is forced down by the pressure from behind, it grinds, breaks, grooves, and polishes its rocky beds, and carries on down the waste material to the lowlands. As it melts all this drops, the water carries the smaller dust out to the sea, and works over the more immovable rubbish, wearing it down bit by bit. In some climates the limit of perpetual frost may be at or near the ocean level. Hence glaciers come down to the ocean, and breaking off and floating away, create the icebergs. These may have rock and stones and dirt in their substance, and carried by the winds and currents drop them here and there over the ocean floor as the contained matter happens to melt out. So rock may be carried a thousand miles from the point of origin.

The finer materials dropped on the ocean bottom, derived from the rivers and from the action of the waves, form beds of sand or mud, which in time, by the pressure of the overlying material which is added and by the pressure of the water, is more or less consolidated into rock; the grains of sand or clay may also be cemented together by the carbonate of lime resulting from powdered shells or other sources, or by iron or other mineral substances gradually sinking on the ocean floor with the mud and sand. Thus the stratified, or bedded, rocks are made beneath the ocean waters.

Heat, or rather the variations in temperature of the interior of the earth, may also do surface work.

There is some difference of opinion as to whether or not the deep interior portions of the globe are or are not composed of rock material in an igneous or fiery state; but at least there is no doubt but that volcanoes afford an outlet to considerable amounts of melted rock material. Granite and other crystalline rocks are found penetrating the beds of stratified rocks in such a way as demands the belief that the injected material has been subjected to the action of heat. Then, too, great folds have been observed in the stratified rocks, showing they have been subjected to enormous pressure. It was at one time thought that the pressure came from below, and that the granite or other melted rock material had mounted upward, elevating and fracturing the rocks above and around them, producing great folds, high tablelands, and extensive and lofty mountain ranges.

At present those who believe in the central fire explain matters in a different way. Without going into details, the layman in science can only remark that it would seem that the most opposite principles are being laid hold of in most approved lawyer-like fashion as logical clubs to win the cause, without care for the consistency which belongs to truth. Does pressure raise the melting point, so that a probable inference springs into view, of an intensely hot interior *kept solid* by the weight of the exterior portions, then we are reminded that there may be a limit to the rise of the melting point through pressure, to save the fluidity of the central portions. Does pressure lower the melting point, and as a consequence a hot solid expand as compared with the liquid, from one point of view the solid crust is shown floating, not sinking; from another side, shrinkage and condensation on cooling of course produces sinking of solid matter into liquid, which is of use in explaining volcanic and eruptive rocks by displacement. I do not mean that the very same matter is represented as both sinking and floating, but only that everything seems to be laid hold of as necessarily in favor of the theory of the melted condition of the earth's interior.

It is at least worth while to show that heat and mountains may result from the simple postulate that there is room for movement in the interior of the earth.

The south cove of Boston was filled in with 900,000 cubic yards of stone. As a consequence of this great weight placed on the bottom (which was below low tide), an adjoining portion of the bottom containing shells, for a space of 75 feet wide by several hundred long, was elevated some five or six feet above high-water mark; and not only so, but the elevated portion was folded and several layers were vertical. But this, some may say, was an effect produced in pliable mud; we may, then, profitably consider this other case: Where a stratum of sandstone rock overlies the coal horizontally, the miners leave certain portions of the coal seam intact, in order to support the sandstone roof above it. And the floor of the worked-out portions has been known to rise up, to become fractured as it rose, and at length to meet the sandstone roof above; the explanation being that the downward weight of rock, where the strata were continuous and unbroken, was unbalanced by a weight at the places where the coal had been taken out, and consequently the less weight of rock had, as it were, moved up to meet the roof. This force was found to be operative at a depth of 56 feet below the floor of the removed coal; for at that depth another coal seam was found, which was fractured and which had moved *upward*, being directly *under the vacant space first left above*. It was further observed that these movements did not take place suddenly, and that wherever the broken and fractured rock fragments exhibited the marks of *most violence*, there the force had been in operation for the *greatest* time.

If, then, the percolating water should remove a considerable body of rock by the action of carbonic acid (or it should be otherwise removed), the effect might be very contrary to natural expectation; the bottom might be pressed up, and the evidence of violence might descend many thousand feet below the hole so made. The removal might be very gradual, and so the rise might be as gradual, and might last for long ages (the forces always acting in the same direction). If now the roof should be entirely removed by the action of rains, rivers, or ocean, a very considerable amount of folding, wrinkling, or mountain making might be exhibited. And according to the rule that the longer the time the greater the apparent violence, the aspect would be that of some extraordinary convulsion of nature taking place suddenly, and some geologists would point to it as an example of the greater intensity of the igneous forces in past geologic time.

Another cause of pressure may be heat, that is, tremendous quantities of rock slowly cooling or slowly heated must move one way or another. And so pressure may be exerted in various directions upon the adjacent rocks; along the points of least resistance these would give way, or be gradually bent and folded, so that heat or pressure may, if time enough is given, produce all the appearances seen in the rocks; and motion in turn, by friction or crushing, produces heat.

But heat does work in a way less doubtful than that of mounting making. It is known as a matter of fact, both from observation and experiment, that heat will alter rocks. Just as soft clay may be baked into a rock like brick, so sandstones, limestones, and stratified rocks in general may be changed to crystalline ones from which every mark of a sedimentary origin has been completely effaced. Granites, for example, may have been at first of pure sedimentary origin, heat, water, and pressure having gradually changed them. From experiments made by a French chemist, Daubree, it is evident that highly heated water under great pressure is capable of producing the constituents of granite from material already existing, and a certain amount of water of constitution is found in granites and other crystalline rocks, which makes it plain that they could not have been formed in a fiery or igneous manner. This water of constitution must not be confounded with the water of percolation, which passes through the substance of the rocks by gravitation.

Living things take part in the surface work of the globe. As destructive agents certain mollusks and articulates operate by boring into rocks, so that the ocean waves have easier tasks in battering them to pieces. Moles by their galleries cut in soil may lead to the extensive drainage of lakes or ponds, and the formation of gorges and river channels cut out by the moving waters. The acids of vegetative origin carried down by the mining waters may dissolve out certain minerals of the underlying rocks, or lead to their rearrangement.

But the hard parts of things that once lived may make rock or lead to the formation of fossil representations of the hard parts. Coal is known to be the carbon of plants. Peat is partially carbonized vegetable matter. Shell sand, ground down by the constant action of the waters upon the stony remains of mollusks, may (together with sand or clay due to river or coast action) be cemented together by the finer particles of carbonate of lime present in the waters to make rock. Sponges furnish flint from the silica of their minute spiculæ. The calcareous shells of minute rhizopods (root-footed protozoans) make up a large portion of chalk rock, as is found upon a microscopic examination. The bottom of the Atlantic is very extensively covered with shell mud of this kind, which, according to Prof. Huxley, no doubt time and pressure will gradually consolidate into chalk. The polyp corals produce the more enduring limestones; and it must be remembered that the modes of the formation of these rocks are no hypothetical matters appealed to in order to explain the past, but that the process is observed as a matter of fact, either going on to-day, from beginning to end, or, as in the case of coal, certain parts of the process are so seen that it is but a fair thing to suppose that the remainder of the process either will at some time take place, or that it is possible that it should take place.

It is observed that now and then the parts of once living animals become fossilized, or that stony representations of them are formed. In a coral reef, for example, which is built up of the hard remains of polyp-making corals, various marine remains may be found sealed up and preserved; sometimes the hard part is bit by bit dissolved by percolating water, and the carbonate of lime redeposited, so that the form remains unchanged, while the hard part is more stony and compact than before. It is found that owing to this fact of percolation, well preserved fossils are most likely to be found in limestone deposits. So they stand a better chance of continued existence in muds and sands, which are *quietly* deposited in ocean or lake waters. Sometimes a land animal may be mired in a marsh, or be drowned in a flood, and be so sealed up in a wet soil that the air cannot get at the remains. Bones may so happen to be preserved for a very long time.

For these reasons marine remains are most likely to be met with as fossils. Land animals are comparatively scarce, and birds still more so.

When we consider the immense multitude of living things which must perish every year over the land, it is really at first thought quite remarkable, as has been said, how very seldom it is that we see a dead animal. But when we reflect upon the carrion eaters, the insects, and the animals that make away with the soft parts (not to speak of the agency of heat, moisture, and the microscopic forms of life), and when we see that there are many animals to dispose of the harder bones, which contain considerable animal matter and marrow in the fresh state, we see that the result is a direct consequence of the very prodigality of numbers which seemed to create the difficulty in the first place.

Land animals will very seldom die so as to be buried in a lake or pond, or be carried down by the rivers to the ocean so as to become fossilized. The bodies distended with gases will in general float for so long a time as to be all pulled to pieces by carnivorous fish, so that the quiet interment of a bone will be a comparatively rare occurrence. Birds being still lighter in comparison, their bones being hollow, their bodies full of air cells, will float for a still longer period, and so will have still less chance of becoming fossilized.

But even if once fossilized or safely buried, the ordinary result will be to obliterate traces of the remains. In dry soils there is a constant percolation, which little by little, owing to the entangled carbonic acid, dissolves out the phosphate and carbonate of lime in bones (and the animal portions soon decay), so that it may very well be the case, even in rocks and perhaps in limestones, that fossils once were there which have been entirely lost to us by the action of the rains. This is no mere inference from theory, but is known to be a fact. Professor Huxley had fossils brought to him for examination which, strange to say, were nothing but holes; but on making casts of the holes, the casts took on the shapes of some of the bones of a great reptile. The holes were in sandstone rock, and, as we have already seen, this sandstone was once loose sand grains; the reptile died, or his body rested at the bottom under water, the sand covering the bones little by little; then the bottom was elevated above tide level, the rain water percolated through and dissolved out the bony matter, but the sand happened to have become sandstone by this time, so that, though the bones were gone, their shape was left behind. If the sand had not become stone, there would have been no evidence left of the former existence of that great reptile. The bones being gone, the sand holes would have collapsed.

JOHN B. WOOD.

A CATALOGUE containing brief notices of many important scientific papers heretofore published in the SUPPLEMENT, may be had gratis at this office.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents, and canvassers.

MUNN & CO., Publishers,
361 Broadway, New York, N. Y.

TABLE OF CONTENTS.

PAGE

I. ENGINEERING AND MECHANICS.—The Aero Condenser.—1 figure 8094
Balancing the Rotary Parts of Machinery.—3 figures 8096
Jacomy's High-Speed Motor.—2 figures 8096

II. TECHNOLOGY.—Useful Directions for Taking Portraits Indoors without a Skylight.—By L. P. FERRIS 8099
The Separation of Bromide of Silver in a Gelatine Emulsion 8099
Photography in a Balloon.—With engraving 8099
How Norwich Shawls are Made 8099
The Cylindrograph.—A new panoramic photographic apparatus.—3 figures 8092
Optical Telegraphy.—Description of the portable optical apparatus.—Transmission and reception of telegrams.—Several figures 8095

III. ART AND ARCHITECTURE.—The Erection of the Duke of Wellington's Statue at Aldershot.—With engravings 8087
Cottages.—Askham, York.—2 engravings 8089
The New Federal Building, Brooklyn, N. Y.—With engraving 8089

IV. PHYSICS, BIOLOGY, ETC.—The Mechanical Production of Cold and the Effects of Cold upon Microphytes.—By J. J. COLEMAN and Prof. J. S. MCKENDRICK.—1 figure 8091
Biological Study of Water.—Apparatus used.—5 figures 8098
A Useful Acaridan.—3 figures 8099

V. GEOLOGY.—A Talk about Geology.—Origin of the word.—Surface work of the globe.—Work of rain drops, great rivers, the ocean, freezing water, etc.—Effect of pressure.—Work of living things 8101

VI. BOTANY.—The Northern Pitcher Plant, or the Side Saddle Flower, Sarracenia Purpurea, L.—By W. K. HIGLEY 8099

VII. PHYSIOLOGY, HYGIENE, ETC.—Physiological Curiosities.—3 figures 8096
Recovery of Good Sight after Twenty Years' Blindness 8096
The Treatment of Freckles, Moles, etc 8097
Insanitary Houses.—A caution 8097

VIII. MISCELLANEOUS.—How to Care for Our Poor Fellow Citizens.—A review of an interesting and valuable work by EMILE CACHEUX 8087
The Lapps.—Their appearance; manner of life; dress; origin; religion; sorcery; etc.—4 engravings 8086

PATENTS.

In connection with the **Scientific American**, Messrs. MUNN & Co. are solicitors of American and Foreign Patents, have had 40 years' experience, and now have the largest establishment in the world. Patents are obtained on the best terms.

A special notice is made in the **Scientific American** of all inventions patented through this Agency, with the name and residence of the Patentee. By the immense circulation thus given, public attention is directed to the merits of the new patent, and sales or introduction often easily effected.

Any person who has made a new discovery or invention can ascertain, free of charge, whether a patent can probably be obtained, by writing to MUNN & Co.

We also send free our Hand Book about the Patent Laws, Patents, Caveats, Trade Marks, their costs, and how procured. Address

Munn & Co., 361 Broadway, New York.
Branch Office, cor. F and 7th Sts., Washington, D. C.

ich
the
ence
d to

ried
s to
dis-
ng a
fish,
par-
r in
full
d so

ordi-
ains.
little
olves
(and
very
line-
been
is no
fact.
exa-
oles;
n the
The
ready
; the
nder
then
rain
bony
sand-
were
d not
e left
bones

OOD.

y im-
n the

ent.

in any
lars a

om the
Price,

n like-
yearly.
r $3.50

AMERI-
UPPLE-

ts, and

Y.

PAGE
er.—1
..... 8094
..... 8094
..... 8095
doors
..... 8099
..... 8099
..... 8099
..... 8099
ratus.
..... 8102
para-
es.... 8103
ke of
..... 8087
..... 8089
g..... 8089
on of
COLE-
..... 8091
..... 8093
..... 8089
—Sur-
ocean,
ngs.... 8101
Saddle
..... 8099
ties.—3
..... 8096
..... 8096
..... 8097
..... 8097
w Citi-
EMILE
..... 8087
origin:
..... 8086

s, MUNN &
d 40 years'
d. Patents

f all inven-
nce of the
ntion is di-
ction often

ascertain,
writing to

rs, Patents,
es
York.
ton, D. C.